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THE KARKINOKOSM, OR WORLD OF CRUSTACEA.

By the Rev. Thomas R. R. Stebbing, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

LITTLE WONDERS AND QUEER BLUNDERS.

Linnæus was no longer in the land of the living, Lamarck had attained to middle life, Latreille was almost a young man, Cuvier was in his boyhood, Savigny and Sabine, if still babies, were at any rate already born, before the least inkling had reached the scientific world of that remarkable group of Crustacea to which the reader's attention is now invited. When the inkling came at last, it came, not as might have been expected, from Sweden or Germany or France, but from Russia. For though it may be, and has been, suggested that Germany had the start by a year, the Teutonic oracle, issued by the celebrated Johann Christian Fabricius, is so obscure that nobody to this day can tell for certain what was intended by it. But the German twilight or the Russian dawn was followed in nearly forty years only by one faint quivering ray, which issued from our own Devonshire. Then a clearer light shone out of America, again with no responsive gleam during nearly a quarter of a century except a fitful shimmer from France. To this day you might search through a hundred intellectual salons, and examine the students of innumerable schools and colleges, without finding any appreciable percentage of persons who could give a reasonable account of the Cumacea.

Nevertheless it was not in inaccessible Russian but in Latin that Ivan Lepekhin described his species in 1780; in 1818 the American, Say, wrote of Diastylis arenarius in the English tongue; and during the last fifty or sixty years a large number of kindred forms have been discussed in various European languages. In the productive effort of this latter period Great Britain and Ireland can claim to have worked early and worked well, though they cannot pretend to compete with Dano-Norwegian science, led by such captains as Henrik Kroyer and Georg Ossian Sars.

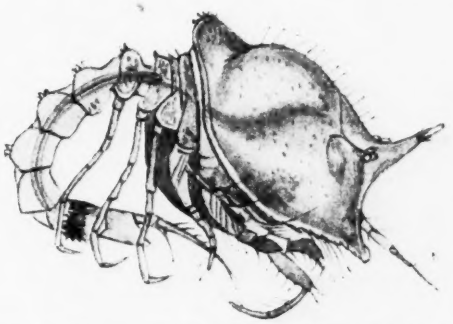

Fig. 1.—*Nannastacus suhmi* Sars. Philippine Islands. From Sars.

After this historic preamble, not to raise false hopes, it is right to explain that these Cumacea have less of Æsop's bull-frog about them than any other order of the Malacostraca. Some of them, like certain of the crabs and family members of all the other orders, dwindle down to absurdly tiny proportions; but none of them ever swell themselves out to that menacing magnitude which many groups occasionally display. In a competition of length, they cannot with their champion species stretch to an inch and a half. Into a competition of breadth they have no temptation to enter. They are essentially of a spare habit. Though, like the lobster and the shrimp, they are conspicuously long-tailed (macrurous) crustaceans, in that very respect they differ most strikingly from the Macrura proper. The tail is not a muscular meat-supplying appendage, but slender, and adapted, like the tail of a scorpion, for sudden and variously divergent wrigglings and contortions. Insignificant in size, however, as they are, their enormous numbers in the North Sea potently help to fatten the shoals of herrings. This is one of the reasons for thinking that the species which Fabricius in 1779 called Gammarus esca, the Food Gammarus, was a Cumacean. The name Gammarus is now re-

stricted to the Amphipoda, as no doubt it already was in the intention of Fabricius himself. Lepekhin in the following year called a Cumacean species Oniscus scorpioides, recognizing by the specific name the likeness to a scorpion, but using a generic name now restricted to some of the terrestrial Isopoda, known as woodlice, and bearing little resemblance to the tribe under discussion, which, but for the "relict" fauna of the Caspian, might be called exclusively marine.

The segmentation of the body and the number, succession, and character of its appendages prove the Cumacea to be a true Malacostracan order. The carapace overarches the appendages as far as the third maxillipeds, usually leaving exposed five pairs of trunk-legs, so that in this respect the Cumacea are intermediate between the higher forms (Brachyura and Macrura), in which all these limbs are as a rule covered by the carapace, and the lower (Isopoda and Amphipoda), in which not five but seven pairs of limbs are left exposed The integument is almost always firmly crustaceous, which excites surprise, because generally such obduracy of covering is met with not in puny forms but in those of considerable size, and not always in them. On the other hand, no surprise bubbles up at the observation that these creatures have no head, that is, no head separated from the thorax, because the astonishing thing would be to meet with a crab or a cumacean or a crustacean of any kind possessing a well-turned neck, except as an anomaly or an abnormality. All the same, our first English observer, Colonel Montagu, good naturalist as he was, let himself be deceived into thinking that in his specimen "the head or fore part was wanting." He had some excuse, since this novel object was only a quarter of an inch long, nor could he find in it either eyes or antennæ. He named it Cancer scor-

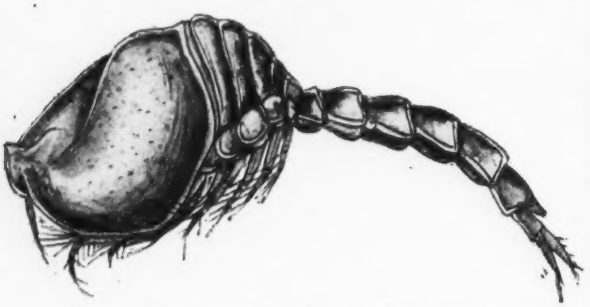

Fig. 2.—*Pseudocuma campylaspoides* Sars. Caspian Sea. From Sars.

pioides, thus independently in a second species recognizing the likeness to a scorpion, while absurdly placing it in the genus Cancer as if it were a little crab—hoping perhaps with a mop to stem the tide of progress which has been persistently comminuting the original genus Cancer, an amorphous lump, into scores and hundreds of more or less shapely genera.

Montagu could find no eyes in his small specimen. The explanation of this may be that the small median eye with its eight lenses had been accidentally obscured. In the Cumacea, as in other orders of crustaceans, there are species which see and there are sightless species. It will be remembered also that the Malacostraca are divided into two great groups, the Stalk-eyed and the Sessile-eyed. The strange thing is that for a great many years the scientific world could not come to an agreement on the knotty point, whether the Cumacea belonged to the former group or to the latter. If they had no eyes at all, well and good, there was no need to argue about the stalks. But successive writers, Lepekhin, Milne-Edwards, Goodsir, affirmed that they had eyes, and Say, though he could not see them, took their presence for granted. Kroyer began by examining species that were really blind. About the same time Goodsir investigated species that really had eyes. Then Erichson, in 1844, expressed what he supposed to be Goodsir's opinion by saying, "the stalked eyes are very small and concealed under the carapace (which no doubt was the cause of Kroyer's

Fig. 3.—*Cumella limicola* Sars. Eyes and front of Carapace. From Sars.

not finding them)." Kroyer, for his part, in 1846, believed the eyes to be what one might call an ocular delusion; and so he says, "Goodsir thought that there must be eyes to be found in the creature and he therefore found them." Goodsir unhappily perished in an Arctic expedition, and was never able to defend or explain his clearly printed statement that "the eyes in this tribe are exceedingly small, they are pedunculated, but sessile." It is amusing to notice how this remark has been treated by subsequent writers. Erichson and De Kay accept the epithet "pedunculated" and ignore the qualifying words "but sessile," which seem to come from the lips of Mr. Facing-both-ways. Kroyer and Bell cannot away with a description which is, as they rightly say, a contradiction in terms. But, look you, in spite of this, in 1870, Anton Dohrn found or fancied in a larval form a little downward bent eyestalk, which at a later stage was completely enclosed by the carapace. This he offers as an olive branch, a symbol of peace, between the disputants, saying, "Curiously both sides are right,—as already before me Henry Goodsir expressed it, 'the eyes are pedunculated, but sessile.'" He seems to forget that Goodsir was concerned not with immature but with full-grown forms. With a boldness greater than Dohrn's, Eugene Hesse, in 1868, described an adult cumacean as having eyes which "are not precisely sessile, nor yet completely pedunculated; they hold the mean between the one thing and the other." What could be more accommodating, what more pacificatory? And, after all, the whole controversy hangs on a misprint, as suggested by Fritz Muller in 1865. Nothing, I think, in this uncertain world can be more absolutely certain than that Goodsir's intention was to say that the eyes are "not pedunculated, but sessile," in accordance with the obvious fact. Only, the printer or the penman left out the inconsiderable word "not." Goodsir goes on to say of the eyes that "they are placed very close together," and that "they are covered by the shell," arrangements not absolutely incompatible with the possession of stalks, though alien to it, but the plates which accompany his description exhibit sessile-eyed species with the most uncompromising plainness. No man in his senses would describe a new scientific object as "long, but short," or "black, but white," without some explanatory signal that he was indulging in a whimsical paradox.

Not the eyes alone excited controversy. A question was raised whether these peculiar little animals were anything more than larval forms, and, what is almost more peculiar than the animals themselves is, that the justly illustrious Henri Milne-Edwards, down at least to 1864, was still on the wrong side of the argument. Though he had himself with some care introduced a Cumacean to European science in 1828, though his attention was repeatedly called to the subject, though he had the writings of Goodsir, Kroyer, and Spence Bate, conclusively showing the right view, he remained obdurate. With him was L. Agassiz, with him apparently, though in less demonstrative fashion, were Dana and Huxley. They all agreed in supposing the Cumacea to be immature forms, and they were all wrong. In fact the Cumacean at birth already resembles its mother, except that the last pair of trunk-legs is as yet undeveloped. A natural warning against the larval hypothesis lay also in the strong sexual dimorphism of these animals. The males are distinguished from the females by the great length to which their second antennæ are developed, by having exopods or swimming-branches attached to all the first four pairs of trunk-legs, and having pleopods on the first five, or some of the first five, segments of the pleon Not often are all these distinctions available together, but always one or more of them. The superior swimming power of the male makes him often at night time a victim to the tow-net sweeping the surface of the sea, while his less agile mate is lying in safety far below.

Some of the species show an almost balloon-like expansion of the front part. But, be it corpulent or slim, its contents are much the same, and worthy of investigation. For this, however, they present a task of some delicacy, being soft and easily damaged goods packed in and attached to a rather unyielding and brittle case. This helps to account for the strange muddle which P. J. van Beneden made in 1861, for, while examining different species, he seems to have lost two pairs of

Fig. 4.—*Cyclaspoides ferox* (Fischer). Bay of Biscay and Mediterranean. From Sars.

the appendages and not to have definitely known which two pairs he had lost. At the same time, by the general excellence of his work, he created a confidence which misled Claus into believing that in the Cumacea two pairs were really missing. That is not the fact. Everything is in order. Those who dissect with the needful skill will find in the Cumacean a heart and "liver," ovarial or seminal ducts, intestinal canal, ganglionic nerve-chain, thinly partitioned branchial chambers, eyes (or no eyes), two pairs of antennæ, mandibles, two pairs of maxillæ, three of maxillipeds, and commonly five pairs of trunk-legs. Of all these the supremely interesting objects are the first maxillipeds. These somewhat leg-like jaws have in their standard features nothing to call for special remark here. The accessories are the essentials. Every Malacostracan appendage, as the reader knows, may possess an epipod on the first and an exopod on the second joint, but these are often inconsiderable, evanescent, or wholly wanting. In these Cumacean maxillipeds they are large and of the first importance, coalesced into a powerful organ, stretching backward, stretching forward, as essential to the life of the Cumacean as they are in some respects unique in Malacostracan structure. The hinder part forms a great branchial lamina, commonly amplified by numerous leaflets or vesicles on its surface. The forepart ends in a pellucid membrane. In some

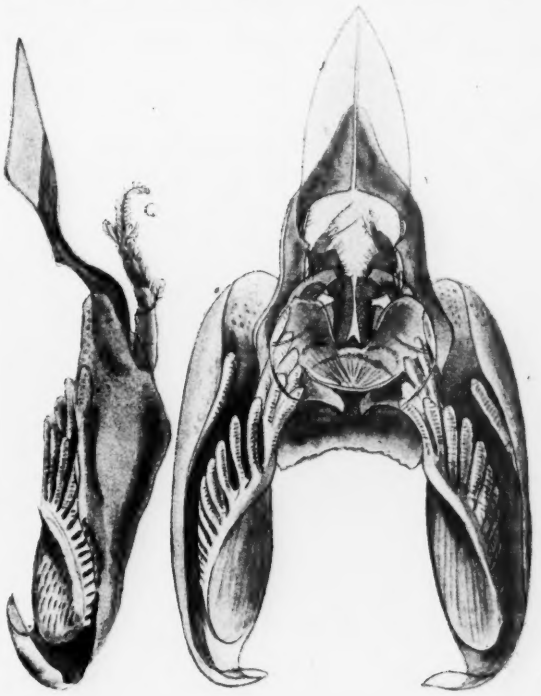

Fig. 5.—One maxilliped of first pair of *Diastylis sculpta*, in lateral view.

Fig. 6.—Maxillæ and first maxillipeds of *Diastylis sculpta* Sars. From Sars.

species, when the animal, alive, and lying still, is viewed in sea water, the pair of pellucid ends will be seen to shoot forward at the front, and then to be in turn withdrawn. When advanced, they form, with the frontal projection of the carapace, a closed but yielding tube through which the water of respiration is expelled. When retracted, they fold over to preclude the return of the used-up water, while the maxillæ make way for a fresh stream to bathe the branchial blade. This apparatus is not constructed precisely in the same way in all the families of the group, and, though the most singular part of the organism both in structure and mode of action, it is not the only part worthy of notice. But space is less at our command than specimens are at the command of the student. To them above all he should have recourse, as well as to the copious literature by which this subject is now illuminated. Among the more recent writers, A. M. Norman, H. J. Hansen and Jules Bonnier are conspicuous, but all the pens and pencils of all the authors on this subject have not produced enough to equal what has been done by G. O. Sars. As for specimens to examine, the sands of the shore, the depths of the sea and its surface, are now known to yield these creatures in abundance, so that there is no longer need to wonder and blunder over solitary examples, though the need for seeing eyes and open minds, for caution and for courage, remains the same as of old.

XUM

SIR JOHN SIBBALD ON SUICIDE.

By Dr. J. G. McPherson, F.R.S.E., Mathematical Examiner in the University of St. Andrews

At a recent meeting of the Royal Society of Edinburgh, Sir John Sibbald, retired Commissioner on Lunacy, gave some very interesting results of his examination of the statistics of suicide in Scotland for many years. And the most startling, though at the same time the most comforting, was his conclusion against the opinions of all who had not carefully investigated the case, as to the increase of suicide. He found that it was not really on the increase.

He first drew attention to the fact that the statistics of Scotland showed the increased number of suicides during May, June, and July, compared with November, December, and January. This coincides with the result of statisticians in other countries. The winter decrease was not owing to the deterrent of cold water by drowning, but in the other forms of wounding, poisoning, and hanging.

In regard to the comparative influence of town and country life on the occurrence of suicide, Sir John found that suicide was not—as was generally supposed—more frequent in towns. In fact, the annual rate per million of population in the eight principal towns of Scotland was somewhat lower than the rate in mainland rural districts.

He found great—even remarkable—differences in the rates for different parts of Scotland, the counties all along the east coast having higher rates than those along the west coast. The average rate for the whole of Scotland (from 1877 to 1894) was 55 per million of population. The lowest rates were for the Highland counties lying north-west of a line drawn from the Moray Firth to the Firth of Clyde. The rate for Inverness was as low as 27; whereas in Kincardine, on the east coast, the rate was as high as 92. This showed that the Scotch statistics bore out the statement of previous writers—that suicide was far less common among the Celtic race than among the Teutons, being a more dreamy and less determined race, and that in this respect the Highlanders and other Celtic people were more like women.

Medical men are of opinion that, although the proportion of the male sex who committed suicide was large in comparison with the female sex, women had quite as strong suicidal tendencies as men, if not stronger, but they lacked the courage to put their feelings into effect. Hence, though the tendency may be as strong in the Highlander as in the Teuton or the Roman, he had not the courage of his suicidal conviction.

Until Sir John gave us the result of his extensive investigation, it was held by most observers that suicide has been increasing to a great and perhaps alarming extent in recent years. The average rate for the years 1865-1869 was 40 in Scotland and 67 in England, whereas the average rate for the years 1890-1894 was up to 54 in Scotland and 86 in England—an increase of 35 and 28 per cent. respectively in thirty years. Two factors come in to account for this. The state of public feeling as to suicide has changed; the belief that an act of suicide necessarily involved disgrace has greatly diminished since suicide has been recognised to be, to a great extent, the result of mental disease; and, in consequence of this change of opinion, efforts to conceal its occurrence have correspondingly decreased. That is one reason. The second is that as suicides have increased, accidents have decreased. In the only case where suicide, by the strict police and registration machinery under statute, is now impossible to be concealed, viz., by hanging, the rate during that period is unchanged: it stands fixed at 16 per cent. in Scotland and 26 per cent. in England. That is an important fact. But turning to the suicides by the other methods—poisoning, wounding, and drowning—it is found that almost exactly as these rates have increased, the rates for accidents from the same causes have decreased. Similar results are shown from the English statistics—that the total increase in the rates of suicide by wounding, poison, and drowning is exactly counterbalanced by a total decrease in the rates of accident from the same causes. Accordingly the alleged increase of suicide is not proven.

Dr. Clouston, one of the highest authorities on mental diseases, followed this up by mentioning a very curious fact—that the average rate of suicide between the ages of fifty-five and seventy is greater than that between fifteen and fifty. He stated his decided opinion that sexual influences mainly accounted for the difference. He showed that up to fifty a man or woman is, or should be, full of life, vigorous, and healthy; consequently possessed of a strong desire for the reproduction of the race; and that while possessed of that feeling he or she had no desire to die, but rather a strong desire to live. On the other hand, in the later years the body became less vigorous, the blood less easily inflamed, and consequently sexual feeling became less strong, and the wish to live gradually passed away and the tendency to suicide became stronger.

Dr. Clouston was also of opinion that excess of alcohol led to a condition of brain which frequently led to suicide. It was not so much worry as drink that was the prevailing incentive. Alcohol, over-indulged in, produced the paralysis of the great human vital instinct of self-preservation.

Sir John Murray instanced another aspect of suicide, and related a curious spectacle of which he was a witness a good many years ago in China. A large number of youths were being examined for some Chinese degree. The examination was held along the bank of a river, each candidate having a small temporary booth fitted up for him on the bank. The opposite bank was lined with thousands of spectators; and when an unlucky candidate failed to pass, he was expected to walk into the river and end his disgrace.

It was pointed out by Dr. Clouston that German authors held that the Roman Catholic portions of their Fatherland did not show so many suicides as the Protestant part. There they had the moral and religious element coming in, which prevented men and women from committing suicide, even when they were diseased and felt suicidal. And Sir John Murray expressed his opinion on this that it would always hold good that in those countries where they had individual responsibility, as they had in all Protestant countries, for opinions and for religious beliefs, there necessarily they would have a disturbance more frequently resulting in suicide than in the Roman Catholic faith, where they had the firm idea of corporate responsibility.

THE EVOLUTION OF SIMPLE SOCIETIES.

By Professor Alfred C. Haddon, M.A., D.Sc., F.R.S.

II.—THE PASTORS OF THE STEPPES.

In my first article, in the February number of Knowledge, I briefly described the social condition of hunting folk, more particularly those of the tropical forests of

South America, as these exhibit a very simple social organisation, but I do not wish it to be understood that I consider all other human societies were necessarily evolved from similar societies to that which I described. It may have been so; on the other hand, there is to my mind no reason why pastoral or agricultural communities may not have independently arisen in some cases from a stage of simple exploitation of natural resources. This I would regard as an earlier stage than that of hunting, employing that term to indicate the quest of beasts, birds, and fishes; whereas in what may be termed "simple exploitation" the natural vegetable products of the forests and jungle form the greater portion of the sustenance of savages at this primitive grade.

I now propose to describe the social condition of perhaps the most permanent and stable of all simple societies—that of the pastors. The materials for this study have been gathered from a series of articles by M. P. Bureau, in "La Science Sociale," Vols. V. and VI., as well as from a paper by M. E. Demolins in Vol. I., and from other sources. At present I am not concerned with the manner in which the herding of cattle may have arisen, but with the life of pastoral peoples on the steppes of Asia, and of these the Kalkas may be taken as typical, as it is generally admitted that these people are very pure representatives of the Mongolian race, and have maintained the old style of life.

Environment.—The country inhabited by the Kalkas is the northern portion of the great Central Asiatic plateau. It forms an immense basin, of which the border attains an altitude of 13,000 to 16,000 feet, and in places much higher still. It extends from latitude 45° N. to 51° N., and from longitude 90° E. to 120° E. This area has an extent of about 500 miles from north to south, and 1250 miles from east to west; it is bounded on three sides by mountains, and on the south by the Ganghin Daban hills, which protect the fertile plains to the north from the inroads of the sand of the Desert of Gobi.

One can understand that in a country so clearly circumscribed its inhabitants can more easily retain their primitive character, foreign influences penetrate with difficulty, and the whole people will preserve their homogeny and similarity of customs.

The altitude determines the peculiar climate, which is inordinately cold, snow persisting on the ground during a greater part of the year. Thus we have the two characters of a steppe—(1) the production of grass; (2) the more or less complete exclusion of other vegetation. This is caused by a short season of humidity regularly intervening each year between a barren winter and a summer, the dryness of which stops the growth of all vegetation. This intermediate season suffices for the growth of grass but is insufficient for the young shoots of trees.

Le Play has pointed out that the snow persists on the plain after it has disappeared on the slopes of the same region, owing to the heat of the sun in early spring melting the superficial snow, and the water filters down into the deep layers, when it freezes in the night and forms a more compact and resistant layer. At length the time arrives when the snow has vanished, the soil, thoroughly soaked with water, is suddenly exposed to an already elevated temperature. The grass grows immediately with an extraordinary rapidity on the incomparably fertile plain.

In several days in the spring the grass grows as high as the waist, and were it not for the dryness and heat of the summer it would everywhere attain the height of a man, as it does in favourable spots; but soon its roots become dry, and the grass lies flat on the ground until the return of spring. Having noticed that the old grass smothers that which is sprouting, the Kalkas sometimes set fire to it at the advent of spring. The fertility of the soil resembles that of the famous "black earth" of Russia and the "yellow earth" of China. The fertility is increased by the abundance of water.

These conditions, so favourable to the growth of grass, are by no means advantageous for agriculture. The soil is fertile enough, but, owing to the altitude, the climate is too severe for grain to ripen.

Winter extends for three-fourths of the year, there is practically neither spring nor autumn, tropical heat succeeds without transition to arctic cold. Huc states that in the country of the Kalkas the cold is so terrible that during the greater part of the winter the mercury of the thermometer freezes. There are also extraordinary diurnal changes of temperature, and consequently great atmospheric disturbances and tremendous storms arise both in winter and summer. No wonder then that such good agriculturists as the Chinese have failed to cultivate the soil.

The seeds of trees spread over the plain before the winter season do not remain inert; sometimes they even germinate before the grass; but they rarely raise themselves to a height of above four inches. Soon swamped in the grass they are stifled, or, at least, blanched. Those that preserve some traces of life are killed by the blazing sun, which, having withered the grass, makes itself felt on the parched ground. This embryo forest perishes annually, because it cannot find in the steppe either the necessary room for growth or sufficient rainfall; but in favourable positions there are forests of pine, fir, larch, and black birch; the aspen and cedar are rarer. In any case the wood is of poor quality.

The most important animal of the steppe is the horse. Wild horses are spread over the whole region, and are so active that they escape from the arrows of the most skilful hunters. Often they move in compact troops, and when they meet tamed horses they surround them and force them to take flight. Cattle and sheep are very numerous, and Nature not only provides them with abundant fodder but has spread salt in profusion all over the country. The Kalka sheep are especially famous. The camel and dromedary are scarce; the pad of their feet is badly adapted for walking on the harsh crust of the snow. They are only used as beasts of burden.

There are a few wild asses, boars are found in the wooded western districts, and wild goats sometimes appear in immense flocks. There is other game, such as deer, antelope, hares, birds, etc. These are automatically kept in check by bears, tigers, and wolves the latter being the worst enemy to man.

Occupation.—From the foregoing account it is evident that the population has only two methods of sustenance—hunting or herding. In the analogous prairies of North America the Red-Skins adopted the former mode of life, or perhaps it would be more correct to say that the absence of the horse compelled them to hunt bison; but in Asia the presence of the horse rendered it possible for the Mongols to tend large herds.

Mr. T. W. Atkinson describes his first visit to a

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Kirghis chief, who possessed more than 2,000 horses, 6,000 sheep and goats, 1,000 oxen and cows, and 106 camels. Even these were far short of the total number of animals belonging to the patriarch chief.

Each day this patriarch had to provide for the fodder and water of nearly 10,000 beasts. The problem would be insoluble for a sedentary people, but the Kalkas find an easy solution in their mobility. The large flocks radiate from the central "aoul," directed by men on horseback. This has to be accompanied by periodic migration. The route is not taken by chance, it requires all the experience and wisdom of the patriarch. However well watered may be the country, the abundance of water is far from equalling that of the pasturage, and the flocks cannot go long without the one as well as the other. It is then that the immense importance of snow is appreciated. It permits the nomads to utilise the forage of the more elevated parts and furnishes them with the wherewithal to water their beasts; further, in covering over the grass, and thus preserving it from contact with the air, it constitutes a kind of immense store-house of fodder; it is, in fact, a huge natural system of ensilage, which the horse can reach with his hoof whenever he has need. Without this protection the grass, exposed to all the inclemencies of the atmosphere, would rapidly perish, and the flocks would be deprived of all nourishment during the winter. The experience of the patriarch leads him to select the most sheltered valleys in the south for the winter and the most northerly and shaded plains for the summer.

The actual care of the flocks is neither a fatiguing nor difficult work. Most often it suffices to sit with crossed legs on a tussock in quietness and peace. The great tranquility of the steppe and the limitless horizon predispose the mind to meditation, and the inaction of the body tends to idleness. Huc says: "The appearance of the prairies of Mongolia excites neither joy nor sorrow, but rather a mixture of both, a melancholic and religious sentiment, a feeling that regards heaven rather than earth, which by degrees elevates the soul without making it entirely oblivious to matters here below."

On the other hand, very often it is necessary for the herder to throw himself on a horse and rapidly pursue a straying animal or some beast of prey. It is no small matter to guard a herd of more than 300 head of large cattle. A saddled horse is always fastened at the entrance of each sentry tent; at the least signal the horsemen, from eight to a dozen in number, rapidly take the direction of the fugitive. Then commences for our Kalkas a giddy course that may last for several days. They do not go to the encampment for news of the straying beasts, but whenever they meet a lama they dismount and prostrate themselves, and say with deep feeling, "Man of prayer, we come to ask you to draw a horoscope; your powers and knowledge are limitless, indicate to us where we should go to recover our horses"; and again they fly like the wind.

The Kalkas have also to protect their flocks from Nature herself. When the winter hurricane tears up the snow, and the plain resembles a sea in its fury, the frightened animals break loose in all directions, and the camels increase the universal tumult with their cries. "Then the intrepid herdsmen courageously fly to the succour of their flocks; one sees them bounding from one side to the other, to encourage the animals by their cries and to conduct them to the shelter of some hill." (Huc.)

The second aspect of the pastoral life explains the agility and remarkable suppleness which, in all times, have made the nomads the finest horsemen in the world. The daily necessity of pursuing animals in flight has given muscular vigour and insensibility to fatigue which is astonishing; but it has not developed a capacity for walking, this a Kalka considers as humiliating. The senses of sight, hearing and smell are wonderfully acute and trained.

The work of the men is essentially attractive, it is more of a recreation than a labour; but it is by no means so for the women. The food these nomads prefer is milk and various preparations from it. All the milking is done twice daily by the women, except that of the mares, who, being more restive, are milked by the men. At foaling time these women have yet more to do; the care of the sick animals also falls to their charge.

The work of the house is exclusively woman's sphere. There are the boiled and fermented preparations of milk, the making of butter and cheese. The women have to fetch in skin vessels the water for tea, for this is the drink the Mongols prefer. They cook and smoke the meat. They collect argols (cakes of dried dung) for fuel, which are dried in the sun; the collecting of argols in winter is especially difficult. Each family group is isolated, and consequently each group has to make nearly all that is needed. Fortunately the pastoral life furnishes in abundance the raw material of these domestic manufactures in the wool and hair of their herds and in their grease and hides. The manufactures are executed at home, and for the sole needs of the home; naturally these fall to the women. Much of this is hard work, especially the tanning of leather and the fulling of wool. The grease of animals is utilised as an illuminant and mixed with ashes to form a soap. Several plants or tea furnish dyeing materials. With the tanned skins the women make water bottles, clothes, shoes, saddles and harness. The fabrics of wool and camels' hair serve for making clothes, whilst felt gives the family spacious and warm tents which protect it from the rigours of winter.

All the labours of shifting camp—of lowering and pitching the tents—fall to the women. This is very arduous work, as the tents are large, with three felted coverings, and it is especially hard when the tents are frozen in winter. The Kalka country is not exactly a paradise for women.

Property.—There is no individual ownership of land The soil belongs to the nation, and to enjoy its use it is necessary to belong to the nation or to formally obtain a concession. A Kalka can, however, camp where he likes provided he does not interfere with anyone else. Thus the temporary possession of land imposes the obligations of neighbourhood and a respect for the pleasure of others. Each must see that his animals do not throw into disorder the flocks of a neighbour or provoke them to flight. When there is a prairie fire every one must, on pain of death, turn out to extinguish it. Concessions are not always irrevocable, as the Chinese have experienced. One day a patriarch, renowned for his courage and wisdom, assembled the Mongols of the neighbourhood, and said: "The Kitas possess themselves of our land, they steal our cattle and villify us; since they no longer act nor speak like brothers we must expel them" The Chinese did not obey the decree ordering their expulsion, so one day they were driven away. According to a Chinese regulation the chiefs chosen by the Emperor to be the

intermediaries of his Government should be the proprietors of the entire soil; it does not appear that this theory has at present any practical consequence.

While landed property is unknown, moveable property in cattle attains a considerable development, as the animals require continual care and watching they necessarily become an object of individual property. Of all the animals the horse takes front rank; it is caressed and extolled with affection in song; money is often lavished on the harness. When a traveller asked a patriarch, the proprietor of several thousand horses, why he did not sell some every year, he replied, 'Why should I sell that which gives me pleasure? I have no need for money, and if I had it, I should shut it up in a box where no one would see it. But when my horses traverse the steppe, whoever sees them knows that they belong to me, and that I am rich." The theft of flocks, especially of horses, is still, more than the usurpation of pasturages, one of the causes of the interminable wars which trouble the tranquility of the steppe. The ownership of a flock is such a necessity for a Kalka that he cannot imagine a man capable of living without owning beasts. It is needless to point out what an element of stability and security the family finds in this property, which, apart from disaster or epidemics, ensures subsistence.

The Family.—The pastoral occupation has permitted the old men to preserve their authority; they alone have the necessary experience and wisdom for it, and it is by no means an easy matter to command four or five hundred persons. As their authority is uncontested, so it is accompanied by absolute respect.

The pastoral art scarcely tends towards the development of riches and luxury, but does tend to maintain between men an almost complete equality, and the isolation of families emphasises the ties of blood.

As husband, the patriarch receives by right the respect and most attentive care of his wife, and as the Kalka has not arrived at the idea of the relations of master and servant he marries as many wives as he can afford in order to have plenty of service, but as the husband has to pay to the parents of the bride a large price in beasts, polygamy is a luxury that is accessible only to the rich and powerful.

The children have a profound veneration for the father, and have to go on their knees when they address him and receive orders from him. Filial piety is the first of the duties, and the "Holy Doctrine" teaches that it is better to honour father and mother than to serve even the spirits of heaven and earth. When the time has come to marry, the wish of the patriarch is sufficient to constrain a son even against his will. It is rare that a young man can consult his taste the first time that he marries. As to the young girls, they are not even allowed to have a wish.

As the depository of the traditions of the ancestors, the patriarch faithfully transmits them to those around him, and all listen with respect. He is the supreme judge of all the members of the aoul, and he has full authority to punish offenders. On sacred days he offers milk and mutton to the image of Buddha, which is placed at the back of the tent.

The first wife enjoys wide liberty and great power, the whole responsibility of the household falls upon her and also the education of the young children. It is therefore important that she should be capable, and that her character should be such that she can get on well with the other women. Such are doubtless the reasons why the patriarch chooses his sons' first wives—the comfort and well-being of the community is of more importance than the predilections of a lad.

Government.—There is no government external to the family. The patriarch combines the functions of father, teacher, magistrate, priest, and sovereign. The sole grouping above the family is the tribe; but it is more an union of several families of common origin than a fixed territorial grouping. The tribe is mobile like the family. The central government has not a more real existence. It is at most a kind of nominal and vague protectorate that is exercised, partly by Russia, and in part by China. It manifests itself by the claim for a tribute, which is rarely collected owing to the difficulty at getting at these singular tributaries.

Peace reigns among the pastors. These men, so dreaded in the numerous raids they have made in other countries, are quiet, sociable, and hospitable in the steppe, where they have no foreign competition to fear.

The Expansion of the Herders.—The pastors of the prairies are apt to swarm, but they are not qualified to organise invasion or to remain masters of the conquered country; but this aspect of their life will be dealt with on a future occasion.

THE PHOTOGRAPHY OF CLOUDS.

By Eugene Antoniadi, f.r.a.s.

A few days after the publication of the paper on 'Clouds" in the September, 1899, issue of Knowledge, the writer received a number of letters from English meteorologists and photographers, asking him to give some further details on the method used in photographing cloud forms at Juvisy. Hence the excuse for the present complementary notes.

The first point to be attended to in cloud photography is to have the camera and plates always ready, so as to be in a position to immediately photograph any evanescent atmospherical phenomenon. Trivial as the statement appears, it is of paramount importance. In fact, without this precaution the negatives of rainbows solar halos, lunar coronæ, etc., would probably never have been secured at Juvisy. As a rule, the persistence of fine cloud effects, or of the optical phenomena of the atmosphere are of very short duration, and the loss of time involved in fetching plates or engaging in other preparatory work at the last moment, is often a source of disappointment; for instance, to see a bright rainbow fade off and vanish when "everything is ready," produces a tantalizing effect too galling to be endured more than once when economy of time will serve as a preventive medicine.

It has been found that the number of days yielding interesting forms of clouds is but a limited one. Long weeks succeed each other without our recording a single typical cloud. Occasionally, however, we may observe the richest forms undergoing rapid and singularly beautiful transitions.

With regard to the choice of an apparatus, it may be said that all cameras, large or small, and mounted or unmounted, can be employed in cloud photography. A large angle lens will be generally found more serviceable, enabling, as it does, the student to photograph clouds of large dimensions, a considerable arc of the rainbow, or ordinary halos of 22° radius as nearly complete circles. But it is, of course, preferable to have a variety of object glasses, capable of being indifferently and rapidly adapted to the camera, according to the nature of the cloud to be photographed.

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The glass should, of course, be provided with a shutter adapted to varying speeds. At Juvisy, an ordinary Thornton-Pickard shutter, with a maximum speed of 1/80 second, has been found very useful. Hand cameras, supplied with speed regulators, act in an equally satisfactory manner.

If a cell containing a yellow solution be used as a screen destined to quench or attenuate the blue of the sky, the distance separating the glasses need not be smaller than $\frac{1}{8}$-inch, or greater than $\frac{1}{4}$-inch. Bichromate of potash, mixed with a few drops of chlorhydric acid, yields beautiful yellows. At the Bureau Central

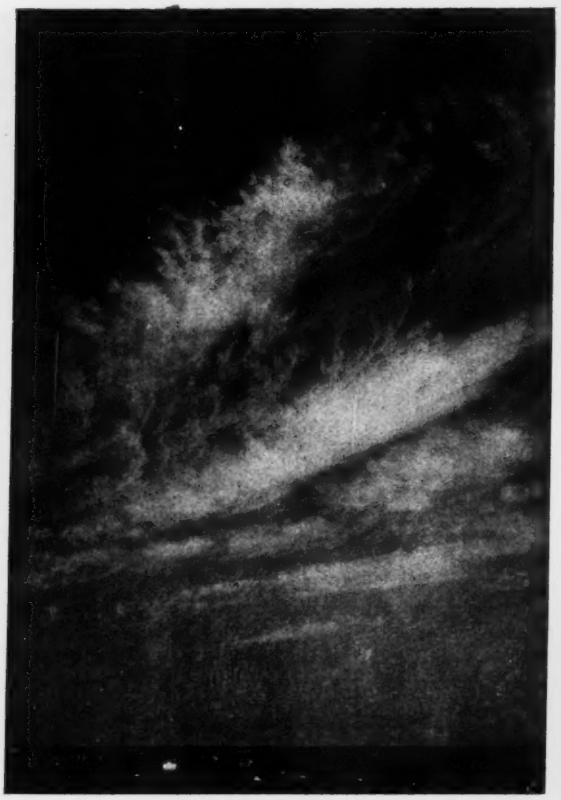

Fig. 1.—Fibred Cirrus, 1899, August, 1d. 2h. 40m., local time.

Meteorologique, M. Angot uses cells $\frac{1}{4}$-inch thick and containing more or less saturated solutions of bichromate, according to the varying intensity of the clouds. The most coloured mixture contains 10 per cent. of the yellow substance; another 5, and a third $2\frac{1}{2}$ per cent. only. The first screen is advantageous on feeble contrasts, such as light cirri near the horizon, or in hazy skies. The 5 per cent. solution is generally the most serviceable on ordinary cirri. The last screen is chiefly used on cumuli. Should the contrast between the silvery crests of the cumuli and the dark blue sky be very marked, then the coloured screen might be dispensed with altogether.

The proper time to give to the exposure is the beginner's stumbling block. In fact, the question is of a very complex character, inasmuch as it depends on a large number of factors, such as the angle of the object glass, the diameter of the stop, the sensibility of the plates, the saturation of the screen, the luminosity of the cloud, the sun's altitude, etc. Laying down a rule for the exposure is an impossibility under such circumstances. But the reader may be interested in the data accompanying the annexed photographs.

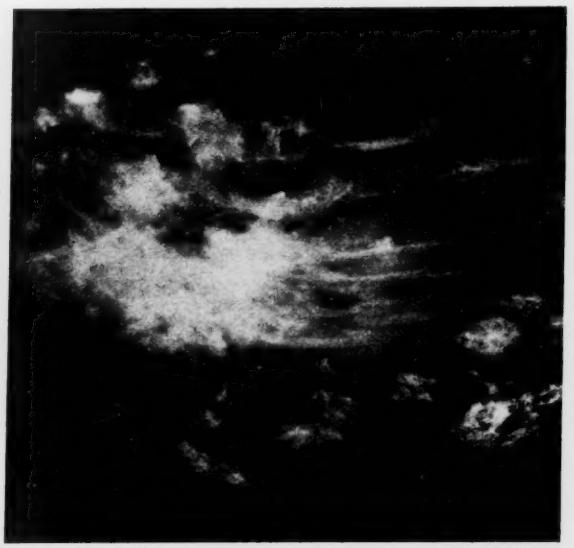

Fig. 2.—Cirrus with Wisps, 1899, August, 1d. 2h. 35m., local time.

Plate, Fig. 1.—Cirro-cumuli transiting across the Sun; following and preceding wet weather. Photograph taken with an object glass 1·04 in. aperture and 5·12 in. focal length. No yellow screen. Stop=$\frac{f}{16}$. Exposure = $\frac{1}{15}$ second.

Fig. 3.—Cloud Ripples, 1899, September, 25d. 2h. 23m., local time.

Plate, Fig. 2.—Gigantic thunderstorm Cumuli during hot, showery weather. Same object glass. Slight yellow screen. Stop=$\frac{f}{16}$. Exposure=$\frac{1}{3}$ second.

Fig. 1 (text).—Cirrus in bands, attending a barometric fall after fine weather. Same object glass. Strong yellow screen. Stop=$\frac{f}{11}$. Exposure=1 second; lengthened on account of the yellow's absorption.

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FIG. 1.—Cirro-cumuli passing before the Sun, 1899, September, 25d. 4h. 3m., Mean Local Time.

FIG. 2.—Thunderstorm Cumuli rolling over Paris, 1899, September, 28d. 3h. 2m., Local Time.

CLOUD PHOTOGRAPHS TAKEN AT M. FLAMMARION'S OBSERVATORY, JUVISY, FRANCE.

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Fig. 2.—Cirrus in wisps. Same object glass. Strong yellow screen. Stop=$\frac{f}{16}$. Exposure=1⅓ second.

Fig. 3.—Undulated Cirro-cumuli, seen during a spell of sunshine during rainy weather. Same object glass. Mean coloured screen. Stop=$\frac{f}{11}$. Exposure 1± second.

It is thus obvious that as far as exposure is concerned, continued practice will be the safest guide. The student should also bear in mind that with a long focus glass, rapidly moving clouds, such as scud flying before heavier masses during a gale, should be photographed with very short exposures only, if he seek to avoid the disagreeable effect of dimness due to the clouds' motion.

(*To be continued.*)

MME. CERASKI'S SECOND ALGOL VARIABLE.

Another remarkable variable star of the Algol class has been discovered by Mme. Ceraski, and is announced in the Astron. Nach. 151, 223. The position for 1900 is R.A. = 19h. 42m.7, Dec. = +32° 28′. From an examination of the Draper Memorial photographs of this star, it appears that while the star has its full brightness on 45 of them, on several of the early photographs it is so faint that they must have been taken when the star was near minimum. The Moscow photographs furnish the means of determining the period from an interval of four years, the Harvard photographs increase this interval to nine years. The period is 6d. 0h. 8m.8. The period differs so little from exactly 6 days that for a long time the minima cannot be observed in certain longitudes. Accordingly, while valuable observations may be obtained next autumn in Europe, or better still in Asia, minima cannot be observed in America until the following year.

Five stars of the Algol class, S Cancri, U Cephei, W Delphini, +45°3062, and the present star are especially interesting, owing to the large variation in their light, which amounts to about two magnitudes in each case. It is remarkable that two of these were found by Mme. Ceraski, and one by her distinguished husband.

Edward C. Pickering.

Harvard College Observatory,
February 12th, 1900.

ASTRONOMY WITHOUT A TELESCOPE.

By E. Walter Maunder, F.R.A.S.

III.—THE NORTHERN STARS.

The stars wear a very different aspect to the astronomer with a telescope and the astronomer without. The former, deep in his observatory dome, sees but a narrow slice of the sky through the open shutter, and the starry groupings as such have little or no significance for him. If he wishes to bring a star within the field of his instrument, he does not as a rule seek it out first on the sky, and there aim his telescope at it like a rifle by its sights. Instead he refers to his catalogue, reads therein the right ascension and declination of the object, turns his instrument until its circles are set to the readings indicated by the catalogue, and then, last of all, moves his dome round until the shutter opening is opposite the object glass. The names of the stars, the constellations in which they are found, have therefore very little significance for him. The important things for him to know are the hour, minute and second to which the one circle must be set; the degree and minute to which the other.

Not so with his brother worker. He stands out under the open heaven; no graduated circles guide his gaze to this star or that. For him, if he will know precisely to what part of the heavens he is directing his attention, it is necessary to be able to recognise the individual stars. In this work differences of brightness and colour are no small help, but by themselves would be perfectly inadequate guides to the recognition of the great majority of the stars. That by which one star can be recognised from another is in most cases its grouping with the rest. The knowledge of such grouping, a perfect and quick recognition of the figures, real or imaginary, which the stars make up amongst themselves, in a word a knowledge of the constellations, is the first essential for the direct observer. It was so from the very beginning. The first astronomers necessarily had no telescopes, and equally of necessity the first great astronomical enterprise was the dividing out of the heavens into constellations, the ascribing certain imaginary figures to particular groups of stars, and the bestowal of names upon individual stars themselves.

The same necessity makes itself felt in every branch of science. Before any progress can be made the objects recognised in that science must be named. Until they are named they are undistinguished and undistinguishable. So far as we are concerned they remain without properties, one might almost say without existence; once named, a knowledge of their properties and peculiarities begins and a whole new field of research is opened out.

And even without this further knowledge, how great an interest is given to any object by the fact that we know its name. Take some town children out into the country, and set them to gather wild flowers, how instantly they ask their names, and how much their beauty is increased in their sight when those names are taught them. And so to-day we are continually hearing the complaint of Carlyle repeated:

> "Why did not somebody teach me the constellations, and make me at home in the starry heavens, which are always overhead and which I don't half know to this day?"

So the work of learning the stars, though it may involve some self-denial, and brings no reward in the shape of "magnificent spectacles," has a charm of its own. The silent watchers from heaven soon become each one a familiar friend, and to any imaginative mind the sense that he is treading the same path as that traversed by the first students of Nature will have a strange charm. With the "Poet of the Breakfast Table" he will feel himself linked to the great minds of the deep unmeasured past.

> "I am as old as Egypt to myself;
> "Brother to them that squared the Pyramids.
> "By the same stars I watch."

However often, therefore, the work of teaching the constellations may have been undertaken, it forms an inseparable portion of my present task.

To us in England, with our high northern latitude, the stars which never set are the first the study of which we should undertake. They are always present, they cover more than one-third of the entire sky visible to us at any moment. They include many conspicuous stars, and form an admirable guide to the constellations beyond the circumpolar region. Constantly revolving round the pole they form, as it were, a magnificent dial plate, marking at the same time the progress both of the night and of the year.

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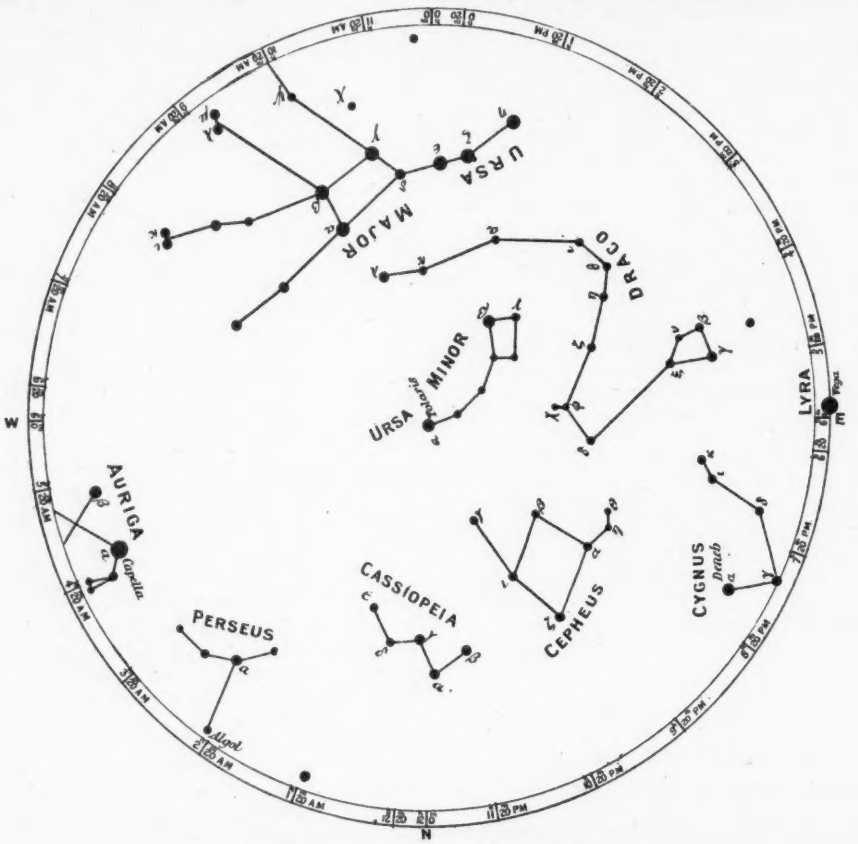
The chief constellation of this region is the Great Bear, the leading stars of which are the Seven, which have won the attention of all races of men in all ages. The seven stars of the Plough or Charles' Wain (the waggon, that is to say, of the churl or peasant) are known to everyone, and form the inevitable starting point for the study of the constellations. Of these seven stars,—which at midnight on the first of April are practically overhead, the greater part of the constellation being already on the downward path towards the west,—the two first are Alpha and Beta, the second pair Gamma and Delta, the four making up the body of the plough, whilst Epsilon, Zeta, and Eta form the handle. Delta is distinguished as being much the faintest of the seven. Zeta by its close companion Alcor visible to any ordinarily good sight.

Alpha are commonly known as the "Pointers," for as the "poet" sings:

"Where yonder radiant hosts adorn
The northern evening sky,
Seven stars a splendid glorious train
First fix the wandering eye.
To deck great Ursa's shaggy form
Those brilliant orbs combine,
And where the first and second point
There see Polaris shine."

A straight line from Beta through Alpha points very nearly up to the pole of the sky, the distance being just a little greater from Alpha to the pole than from Alpha to Eta, and close to the pole shines the Pole star, a brilliant of the second magnitude, and placed at the end of the tail of the Lesser Bear as Eta is at the tip of that of the Greater.



The Chief Circumpolar Stars, midnight, April 1st, 1900.

Regarding the constellation as the "Great Bear," the four stars in the body of the Plough make the hindquarters of the animal, whilst the handle becomes the bear's tail. The feet of the bear are clearly pointed out by a curious set of three pairs, Iota and Kappa make the first, Lambda and Mu the second, Nu and Xi the third. These form the great plantigrade feet of the animal, and are "the does' leaps" of the Arabs.

A line drawn from Zeta through Alpha and carried forward the same distance the other side brings us to the fourth magnitude star Theta at the point of the creature's snout. These stars enable the boundaries of the constellation and the figure which it is supposed to represent to be easily detected in the sky. Beta and

The chief stars of the Little Bear, like those of the Greater, are seven in number, and in arrangement form a rough and fainter copy of the Plough. Between the two bears it is easy to trace out an irregular winding line of fairly bright stars. This is the Dragon the Serpent of the following lines from "Aratus":

"Between these two, like to a river's branch,
A mighty prodigy, the Serpent twines
Its bendings vast around; on either side
His coil they move and shun the dark blue sea.
But o'er the one his lengthy tail is stretched,
The other's wrapped in coil."*

Alpha Draconis, sometimes called Thuban or Rasta-

* Brown's "Aratus," p. 16.

ban, lies midway between Zeta Ursæ Majoris and Gamma Ursæ Minoris.

Starting from Epsilon Ursæ Majoris, the star in the Great Bear's tail nearest the root, and crossing the North Pole, we find on the further side of the Pole, right upon the sparkling background of the Milky Way, here almost at its broadest, five stars in the shape of a W, the principal stars of the constellation Cassiopeia, the "Lady in her Chair." At midnight on the first of April, this group is low down in the north; the W being, as it were, written in a dropping line from left to right, that is from west to east, as if scrawled by a tired writer. The lettering of the stars is nearly but not quite in the reverse order of writing. Reading from left to right they come Epsilon, Delta, Gamma, Alpha, Beta, the three last named being distinctly brighter than the other two.

Starting from Cassiopeia, and following the Milky Way towards the west, we find a number of stars marking out the spine of the Galaxy, and bending down in an elegant curve to the bright somewhat yellow star in the north-west. The stars in this curve are the principal members of the constellation Perseus, and the bright yellow star at the end of the curve is Capella, Alpha in the constellation Auriga. It is a star impossible to mistake, since close beside it is a very pretty little right-angled triangle of moderately bright stars.

Following the Milky Way towards the east, we find a bright star in the centre of the Galactic stream and about as far from Cassiopeia on the east as Capella is on the west. This is Deneb, Alpha in the constellation Cygnus, and it forms the head of a magnificent cross of stars. A little further along the Galaxy we come to another star not quite so bright, but of a slightly warmer tinge. This is Gamma, the star which marks where the two beams of the cross intersect. Above and below Gamma are other stars, making up a magnificent curving line, the transverse beam of the cross, or, if we prefer so to regard it, the upper outline of the outstretched wings of the Swan. A straight line from Alpha through Gamma and along the spine of the Milky Way, leads through a succession of considerable stars to Beta, which marks the Swan's beak, or the root of the cross.

Somewhat above the Swan and further to the east, and making very nearly a right-angled isosceles triangle with Beta and Gamma, the right angle being at Beta, is a splendid steel blue star, Vega, the rival of Capella in brightness, the two being claimants for the premiership of the northern heavens. The five bright stars which wait upon Vega in its immediate neighbourhood, and of which the nearest, Epsilon, is a very close double to keen sight, make up with it the constellation of Lyra, a constellation which lies for the most part outside the circumpolar circle for the latitude of London.

The chief guiding stars, therefore, for the northern heavens, are the well-known Plough, the scarcely less distinctive little W of Cassiopeia on the opposite side of the Pole, and the two great brilliants between them on the right hand and on the left, Capella and Vega. All these are continually visible for Scotland and the North of England; for the southern part of our island Vega is lost for a short time when due north.

Only one important group among the northern constellations has now been left undescribed. This is Cepheus, the Ethiopian king, a constellation of no great brilliancy or distinctiveness, and lying between the Dragon and Cassiopeia; the feet of the figure are supposed to stand on the Pole of the sky.

The accompanying map shows the position of the circumpolar region with regard to the north horizon at midnight on the first of April. The figures ranged round the circumference of the map show the position of the north point of the horizon for hourly intervals of the day and night at that time of the year. For other dates in the year we can find its position nearly enough by remembering that for every month later in the year that we take we must also take two hours earlier in the evening to obtain stars in the same position, or if we take a single day later in the year then we must choose our time four minutes earlier.

EARTHQUAKE-SOUNDS.

By Charles Davison, sc.d., f.g.s.

The sound which accompanies an earthquake has rarely, if ever, been described more graphically than by an observer of the Charleston earthquake of 1886. He was at the time on the second floor of a lofty building in Charleston when his attention was "vaguely attracted by a sound that seemed to come from the office below, and was supposed for a moment to be caused by the rapid rolling of a heavy body, as an iron safe or a heavily laden truck, over the floor. Accompanying the sound there was a perceptible tremor of the building, not more marked, however, than would be caused by the passage of a car or dray along the street. For perhaps two or three seconds the occurrence excited no surprise or comment. Then by swift degrees, or all at once—it is difficult to say which—the sound deepened in volume, the tremor became more decided, the ear caught the rattle of window-sashes, gas-fixtures, and other movable objects. . . . . The long roll deepened and spread into an awful roar, that seemed to pervade at once the troubled earth and the still air above and around. The tremor was now a rude rapid quiver, that agitated the whole lofty, strong-walled building." Soon "the floors were heaving underfoot, the surrounding walls and partitions visibly swayed to and fro, the crash of falling masses of stone and brick and mortar was heard overhead and without, the terrible roar filled the ears and seemed to fill the mind and heart, dazing perception, arresting thought . . .", until at last "the uproar slowly died away in seeming distance. The earth was still, and oh! the blessed relief of that stillness!"*

Though the chief features of the earthquake-sound are described in the above extract, its character varies considerably in different earthquakes, in various parts of the area of one and the same earthquake, and even with individual observers in the same house. For several years I have paid special attention to the phenomena of earthquake-sounds† and have collected several thousand descriptions, the types of comparison employed belonging generally to one of the classes mentioned below. Occasionally, however, an observer is uncertain, and quotes alternative types which may belong to different classes. But often the resemblance is so close that he is himself deceived, and starts up from his chair to see the unexpected carriage pass.

(1) The most frequent references of all are to passing vehicles of various kinds, and, as a rule, to very heavy ones, such as traction-engines, steam-rollers or waggons,

* C. E. Dutton, Amer. Geol. Survey, Ninth Annual Report, pp. 212-213.

† See a paper in the *Phil. Mag.* for January, 1900, of which the present paper is an abstract.

driven rapidly over stone paving or on a hard or frosty road; express trains or heavy goods trains rushing over an iron bridge or through a tunnel or cutting; or weighty furniture dragged along the floor. (2) Next in frequency come comparisons to thunder, occasionally to a deep peal, but most often, perhaps, to distant thunder. (3) In some earthquakes, but by no means in all, the sound appears to resemble a rough or moaning wind, the howling of wind in a chimney and a chimney on fire. (4) When it is of short duration and fairly uniform in intensity, we find the sound described as like that of a load of coal or bricks falling from a cart, or of a wall or roof tumbling down. (5) Again, when still briefer, it is compared to the thud of a ponderous weight, a large mass of snow or of heavy timber, or the slamming of a door. (6) In weak earthquakes, and above all in the slight after-shocks of a great earthquake, we have references to explosions of different kinds, but chiefly to colliery explosions, rock-blasting or the firing of artillery, especially when they occur at a distance. (7) Lastly, there are several descriptions of a miscellaneous kind, which are rarely used and do not fall under any of the above headings, such as the trampling of many animals, a covey of partridges on the wing, the roar of a waterfall or the rumbling of waves in a cavern.

To most observers and over the greater part of the disturbed area, the sound remains of the same character throughout. There is nearly always a very perceptible change of intensity, the noise growing gradually louder and then dying away, and the change sometimes takes place so uniformly that it seems as if a carriage were coming up rapidly to the door of the observer's house and afterwards receding on the other side. Close to the epicentre (or area vertically above the seismic focus), a change in the character of the sound is also noticeable at or about the instant when the shock is strongest; some hear a loud crash like the explosion of a bomb-shell; to others, it appears rougher and more grating; while a large number perceive no change at all. At moderate distances, the changes are much less marked; before and after the shock, the sound resembles the moaning of the wind, and, while the shock lasts, a more rumbling character is developed. At great distances, the change in character is hardly sensible; there is little, if any, variation in intensity, and the report, when heard, resembles more than anything else the deep boom of distant thunder.

The extraordinary depth of the sound is shown very clearly by the descriptions given above. The frequent and unprompted use of the word "heavy," whether applied to thunder, explosions, or traction-engines, is some evidence of this. The same impression is also conveyed by the more detailed accounts; "much lower than the lowest thunder" one observer writes, and another, "I can only compare the sound with the pedal notes of a great organ, only of a deeper pitch than can be taken in by the human ear, shall I say a noise more felt than heard?" Still more striking is the fact that, while the sound is heard by some observers, it is quite inaudible to others at the same place and even in the same house. To one person the sound is so loud that it seems like the rumbling of a heavy traction-engine passing; another in the same place and equally on the alert will be just as positive that the shock was unaccompanied by sound. The explanation offered rather confidently by some writers that the attention of the second observer was distracted by the shock is untenable for several reasons, which may be worth mentioning. (1) In the first place, the sound is often too loud to escape notice in this way. (2) It is generally heard before the shock begins to be felt. (3) Different races, as will be seen afterwards, vary much in their powers of hearing the earthquake-sound. A whole nation, and especially one so accustomed to observing earthquakes as the Japanese, cannot be accused of constant inattention. (4) Lastly, my own hearing is, I believe, unusually keen for ordinary noises, but I could hear no sound during the Hereford earthquake of 1896, though I was in a quiet room and listened intently, and more than 60 per cent. of the observers in Birmingham heard the earthquake-sound. We may therefore conclude that the inaudibility of the sound is not due to inattention, but simply to the fact that some observers are deaf to very low sounds.

Another fact deserving of notice is that the sound-vibrations are not all of one pitch. The loud and deep explosive crashes observable near the epicentre at the time when the shock is strongest are only heard by some persons. Again, the observers at any one place make use of widely different means of comparison. Thus, out of more than fifty observers of the Hereford earthquake in Birmingham, 35 per cent. compared the sound to passing waggons, etc., 18 per cent. to thunder, 17 to wind, 4 to loads of stones falling, 9 to the fall of heavy bodies, 11 to explosions, and 6 per cent. to miscellaneous sounds. The difference in loudness was also very marked. On the one hand, we have such descriptions as a traction-engine passing, an express train rushing beneath an arch, a heavily laden cart passing over a rough street, and heavy thunder; on the other, distant thunder, a rushing wind and a very distant explosion. If all the observers in one place were equally endowed, the sound would present the same character to every one of them. But their powers differ widely. Their ears, indeed, act like sieves of varying degrees of fineness; some are affected by many vibrations, and to them the sound is loud and complex; others are impervious to all but a few vibrations, and they hear a sound that is apparently faint and monotonous.

As the inhabitants of any one country do not agree in this respect, it is only natural to suppose that "different races should also vary. The people of Great Britain seem to have unusually good powers of hearing earthquake sounds. It may fairly be said that an earthquake never occurs in these islands without the sound being heard. It is not altogether easy to make a just comparison with other nations, for we cannot be certain that the omission of sound-records is not accidental. There are, however, two countries, Italy and Japan, where earthquakes are closely studied. In Italy about one-third, and in Japan about one-quarter, of the earthquakes seem to be accompanied by sound. But there is this difference between them. The Italian shocks, which are unattended, so far as we know, by sound, are generally felt by very few persons; when there are many observers, there are always one or more to be found among them who are capable of hearing deep sounds. But, in Japan, although the proportion of audible earthquakes increases with the area shaken by them, nearly one-third of the strongest shocks are unaccompanied by any recorded sound. The only inference we can make from this is that the Japanese, as a race, are less susceptible than Europeans to very low sounds.

The more or less limited size of the area over which the sound is heard is also evidence of the less or greater deafness of observers for low sounds. In Great Britain,

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the sound is heard with every earthquake, and by a large proportion of the observers who feel the shock; and here the sound-area is always large. In weak earthquakes, the noise is heard further than the shock is felt; in strong ones, it has been heard as far as 180 miles from the epicentre. In Japan, on the other hand, the sound is inaudible at a distance of a few miles from the epicentre. Of the earthquakes which originate beneath the land, about one-quarter are accompanied by sound; while this is the case with less than one per cent. of those which have submarine foci, although more than nine-tenths of the epicentres were not more than ten miles from the coast. Indeed, so deaf are the Japanese to the earthquake-sound that it is probably heard by them only in the case of those shocks which originate at a very slight depth below the surface of the ground.

In all countries, however, the sound-area is less than the disturbed area of a strong earthquake; and in a disastrous earthquake it may occupy only a comparatively small region in the neighbourhood of the epicentre. But there is no constant relation between the two areas; for, in moderately strong or weak earthquakes, they nearly coincide, or the sound-area even overlaps the other on one or more sides; while, in a very weak earthquake, it overlaps it in all directions. Moreover, there are some very interesting cases in which the disturbed area ceases altogether to exist, that is, the sound is heard while no shock whatever is felt.

That such earth-sounds have the same origin as ordinary earthquakes is highly probable. They are heard in districts where slight shocks are frequent; and sometimes a series of earth-sounds is interrupted by a shock accompanied by a precisely similar noise. A great earthquake is always followed by a crowd of after-shocks, among which earth-sounds occur in great numbers at places near the epicentre. It would therefore seem that earthquakes and earth-sounds may be traced to the same cause, that the chief difference in reality lies in ourselves, in the sense by which we perceive them—in other words, that an earth-sound is merely an earthquake too weak to be felt.

A point of some importance is the relative position of the sound-area and disturbed area of an earthquake. So far as known, the two areas never have the same centre. Their longer axes are parallel to one another, but the sound-area is always displaced with respect to the other, sometimes in the direction of the longer axis, but generally in that of the shorter axis. In the latter case, moreover, the displacement takes place towards the line of the fault with which the earthquake appears to be connected, implying that the loudest sound-vibrations do not come from so deep-seated a portion of the fault as the vibrations which constitute the earthquake-shock.

In old earthquake catalogues, the sound is generally said to precede or accompany the shock, very rarely to follow it; in Japan, the sound is seldom, if ever, heard after the shock ceases to be felt, but it is nearly always heard before the shock begins. We may fairly infer from this that the fore-sound is louder than the after-sound. More detailed studies of recent British earthquakes show that the beginning of the sound generally precedes that of the shock in all parts of the sound-area; while the end of the sound more frequently follows that of the shock than otherwise, even at very great distances from the centre. In weak earthquakes, the instant when the sound is loudest always coincides with that when the shock is strongest; and this is generally, though not always, the case with strong earthquakes. The duration of the sound is as a rule obviously greater than that of the shock.

In order to give definiteness to the explanation of the phenomena described above, I will assume the truth of the theory which ascribes non-volcanic earthquakes to the friction produced by the sliding of one of the rock-masses adjoining a fault over and against the other. The seismic focus in such a case must be a surface inclined to the horizon, and the relative displacement of the two rock-masses will be greatest near the centre of the focus and will die away towards the edges. Thus, from all parts of the focus, there must proceed vibrations differing in amplitude and period, the large and slow vibrations coming from the central region, and the small and rapid ones from the margins. It is the latter, I believe, especially those which come from the upper and lateral margins, which are responsible for the earthquake-sounds.

It is evident, on this view of their origin, that the sound will become gradually louder until the shock is felt, and afterwards die away. The intensity of the sound will also increase with that of the shock in different earthquakes; but while the marginal vibrations are limited in amplitude and period, those from the central parts of the focus have a wider range, and therefore the intensity of the sound will not be proportional to that of the shock. Similarly, in a violent earthquake, the disturbed area will extend far beyond the sound-area; while, in a weak earthquake, the latter area will overlap the former. In the limit, the central region of the focus will vanish, and the sound will be heard without any accompanying shock.

The most perceptible sound-vibrations will be those which come from the upper and lateral margins of the focus, and the boundary of the sound-area, with respect to that of the disturbed area, must therefore be shifted towards the fault-line, and also in the direction of the fault if one lateral margin be longer horizontally than the other.

The sound-vibrations from the margin nearest to the observer will be heard before the shock begins, those from the upper margin and the central region during the shock, and those from the furthest margin after the shock ends. Thus, the fore-sound, on account of its nearer origin, will be more generally noticed than the after-sound; and, for the same reason, will be the only sound heard by Japanese observers. The after-sound will be less frequently heard as the distance from the origin increases; and the duration of the sound, especially at places near the epicentre, will be greater than that of the shock.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE UNIVERSE INFINITE?

TO THE EDITORS OF KNOWLEDGE.

Sirs,—The letters of some of your correspondents, including Mr. Inglis, the latest of them, leads me to suggest a form of the above problem which will keep us clear of the theoretical difficulties about infinity. I would therefore substitute, Does the stellar universe extend to 1,000 times the average distance of a star of the sixth magnitude?

The answer seems to me to be, Certainly not, unless (1) there is a medium in space which absorbs light, or

(2) a rapid thinning-out of the stars as we proceed to a great distance from the sun, or (3) a rapid decrease in the luminosity of the stars—which would have the same effect as a decrease in their number.

Taking the successive members of our series as the stars of each successive magnitude, it would be an increasing, not a decreasing, series, on the assumption that the distribution of the stars was uniform, and that there was no absorptive medium. Adopting Pogson's scale, the total light of the stars of the n+1th magnitude would always be equal to 1.585 times the total light of the stars of the nth magnitude. Can any reasonable man who looks at the sky imagine that this process is carried as far as the stars of the 1000th magnitude?

What light an infinite number of stars situated at an infinite distance might or might not give us is an insoluble problem. I only profess to deal with stars at finite distances. The main question is whether there is a gradual thinning-out of these as we proceed to great distances from the sun. I hope your future correspondents will confine themselves to this issue.

The distance of the sun from its nearest neighbour and Centauri is so vast that many persons seem to conclude either that we do not belong to the Galactic System or that we are situated in a void space in the Galaxy. I cannot see that either of these alternatives has been proved. The sun, so far as I can judge, is very probably a Galactic Star situated in a region which is neither unusually dense nor unusually rare. If so, a great diminution in the density of the stars may be expected when we once get outside of the Galactic Cluster. The stars outside of it may, notwithstanding extend to infinity or even be infinite in number, but then much more sparse distribution outside of the Galactic Cluster would account for what we see.

The Galaxy, as we see it, is nearly a great circle on the sphere This fact suggests that the sun (and earth) is in it, not outside of it—if indeed the galaxy is not a hollow ring near the centre of which we are situated. But the gradual decrease in the density of the stars as we proceed towards the Poles of the Galaxy is hardly consistent with the theory that the sun occupies an open space in the centre of the ring. There may have been something in the old idea that the earth was the centre of the Universe—viz., that it is one member of vast central constellation, and may therefore be regarded as the actual centre when the distance considered is sufficiently great W. H. S. Monck.

P.S.—When I first wrote on the subject I fell into the same error as Mr. Inglis, viz., that on the hypothesis of uniform distribution the total light of the stars of the nth and n+1th magnitude would be the same. I made this mistake in consequence of considering the surface of the sphere instead of its solid contents. I was fortunate enough to be the first to point out the error into which I had fallen. But I am afraid that I am theorising too much for your reviewer.—W. H. S. M.

IS THE STELLAR UNIVERSE FINITE?

TO THE EDITORS OF KNOWLEDGE.

Sirs,—Mr. Monck writes: "Bright stars lose as much by absorption, atmospheric or telescopic, as fainter ones." Individually they do not lose the same proportion of their total light, which is the essential point so far as my argument is concerned. A faint star becomes invisible near the horizon, while a bright star still remains visible at a similar altitude. Although the combined light of a number of stars too faint to be separately visible may certainly, as he points out, produce the sensation of light, yet if the atmosphere absorbs so much of the light of each individual star as to render it invisible as such, then none of those stars are included in the counts or gaugings of stars on which Mr. Burns relied, although they might actually exist. Conclusions, therefore, based upon these counts, absorption being neglected, appear to me to be erroneous.

Wm. Anderson.

Madeira, February 12th, 1900.

THE CONSTITUENTS OF THE SUN.

TO THE EDITORS OF KNOWLEDGE.

[I was wrong, no doubt, in writing "dark," seeing that the laboratory spectrum of carbon consists of bright lines. But even if we deal with these bright lines or flutings, I still maintain that the coincidence of all of them with dark solar lines is not made clear to me in Fig. 3. I admit that the fluting beginning at 3879 and ending at 3883 corresponds generally with that in the solar spectrum, but the break or change in continuity shown in the latter at about 3882 does not appear in the carbon spectrum; neither does the abrupt termination of the fluting coincide exactly in position with that of the dark. Then, again, as to the beautifully regular fluting commencing at 3874 and ending at 3878, there may be a dark line corresponding in position to each of the brighter, but the general character of the fluting is by no means represented on the dark lines—that is to say, the very slight but regular crowding together of the lines towards the right. Similarly at wave lengths lower than 3874, no particular correspondence suggests itself to my eye. I do not deny that there is a correspondence between the lines of carbon generally, with dark lines in the sun; I merely reiterate that the figure in question does not, to me, give that convincing visual coincidence which the text-books lay stress upon as proving beyond possibility of doubt the existence of certain elements in the sun.—E. E. M.]

[To my former remarks I need only add that in the solar spectrum the flutings of carbon are superposed upon lines due to various other elements, so that except in the case of the fluting commencing at 3883, the correspondence with the arc spectrum of carbon is not very striking. Nevertheless, Rowland finds that 145 of the solar lines between Lambda 3883.5 and Lambda 3864.0 agree with the component lines of the carbon flutings In the diagram I indicated only the most obvious of these coincidences, and showed also that the break in continuity at 3882 was due to the presence of a line of cobalt.—A. F.]

Notices of Books.

"The Races of Man; an Outline of Anthropology and Ethnography." By J. Deniker. Contemporary Science Series. (Walter Scott, Limited.) A popular work on his favourite science by such a distinguished anthropologist as Dr. Deniker, the Chief Librarian of the Paris Museum of Natural History, can scarcely fail to be a masterly treatise on the subject, and should merit the best attention of his fellow-workers in this country, even if they be disposed to doubt the correctness of some of his views. As its title implies, the work treats of man not only from a zoological, but likewise from a physiological and sociological standpoint, so that it deals with anthropology in its most comprehensive sense, the greater part of a chapter being devoted to language and its evolution. No less than 170 illustrations—some of full-page size—are employed to convey an adequate idea of the leading types of mankind, and the mode of dress (or "undress") of the various races. The care with which these illustrations have been selected, and the excellence of their execution, will scarcely fail to be

appreciated by those who know how difficult it is to obtain a good series of representative types. In the introduction the author treats of the difficulty felt by all anthropologists in dealing with man from a systematic point of view; "species" and "races" being in his case scarcely comparable with the sense in which those terms are used in ordinary zoology. He next proceeds to show in what respect man differs from or resembles apes and monkeys; from which he is naturally led on to the consideration of the distinctive characters of the various races of mankind. Physiological characteristics, inclusive of cross-breeding and the cosmopolitanism of man, next claim attention; after which we find four chapters devoted to language and sociology. In this latter section of the subject is embraced all connected with man's individual and social life; and we learn how dress has been gradually evolved from ornament, the manner in which social organization has developed, the evolution of the complicated commercial system of the present day from the original barter, and, in fact, all that has to do with the formation of society, so far as is possible in the space at the author's disposal. In the eighth chapter, Dr. Deniker comes to the classification of the various races of mankind; while the remaining five chapters treat in detail of the races and peoples of the various continents and archipelagoes of the world. In his classification of mankind the author lays great stress upon the character of the hair as a feature of prime importance, giving a table explanatory of the manner in which he proposes to arrange the different races according to this standard. While the system thus formulated presents a very considerable agreement with the one so largely adopted by English anthropologists of the present day, it lacks the brigading of the races into three or four primary stock-groups, and is therefore, in our opinion, likely to confuse the general reader, who will find it somewhat difficult to grasp the author's conception of the mutual relationships of the various races. We are, however, pleased to find that the view recently expressed in KNOWLEDGE as to the wide gulf between the aboriginal tribes of Australia and Negroes, and the affinity existing between the former and the inferior races of India and Ceylon, also commends itself to the author of the volume before us. As a matter of fact, all the races classified by Dr. Deniker as "woolly-haired" correspond to the Negroid stock (minus the Australians) of the late Sir William Flower's classification; his curly and wavy-haired races to the Caucasian, and the straight-haired races, which include the Mongols and American Indians, to the Mongoloid stock. The separation in the table of the South American from the North American races is, however, to be regretted; as is likewise the author's disinclination to recognise the Malays as a distinct race. It may also be mentioned that his usage of the term "Indonesians" seems scarcely justifiable, since it was framed to include all the inhabitants of the Malayan Islands and Oceania, coming under the designation neither of Melanesians nor Malays, and yet we find Dr. Deniker retaining the designation of Polynesians for the Samoans and their kindred. To follow the author into the detailed description of the races and tribes of the various continental and insular areas of the globe, would be impossible within the space at our command. But it may be mentioned that he is very sceptical not only as to whether there were ever an "Aryan" people, but even as to the existence of a corresponding language. It is likewise noteworthy that he employs the term "Ethiopians" for the Hamitic races of North-east Africa, and if, as is very probably the case, this usage is correct, it may be a matter for consideration whether we are justified in continuing to employ the designation "Ethiopian region" for Africa, south of the Sahara, as is so generally the practice in zoo-geography. In the case of a foreigner the error of "Black Continent" instead of "Dark Continent" (p. 427) is perhaps excusable; but the perpetuation of such an obsolete title as Cervus tarandus (p. 305) for the reindeer is not so easily pardoned. While fully appreciating its many excellent features, we would recommend anthropological students not to confine their attention to this volume, but also to read works like those of Professor A. H. Keane, in which somewhat different views are expressed. They will thus be in a position to take the via media in cases of doubt and difficulty.

"The North American Slime-Moulds." By Thomas H. Macbride, A.M., PH.D. (New York: The Macmillan Company.) 10s. net. The Myxomycetes, or Slime-moulds as Prof. Macbride prefers to call them, have recently been introduced to readers of KNOWLEDGE through the interesting papers by Sir Edward and Miss Agnes Fry which appeared during 1899. These authors have made the organisms familiar to us under the much prettier name of "myxies." The myxies are at the two important stages of their life-history totally different in character. During the growing, or vegetative, phase they are merely undifferentiated masses of protoplasm hardly distinguishable from an ordinary amœba. Indeed, in some systems of classification they have, at this stage of their growth, been placed in the animal kingdom. It is thus perceived that Prof. Macbride's volume is concerned with the interesting borderland which by some authorities is claimed for the kingdom of zoology and by others for the realm of botany. But whether after a short or longer period of time the fruit, or reproductive phase, in the life of the myxomycetes at last arrives, and is accompanied by a total change of characters. The organism seeks the light, and the object now to be attained is not only the formation of spores, but the rapid drying up of the parent and the effective distribution of the fruit. The author describes how this desiccation sometimes occurs suddenly "as if by magic charm into one widespread, dusty field of flying spores." With reference to the perennially interesting question as to whether the slime-moulds are plants or animals, Prof. Macbride says, "Why call them either plants or animals? Was Nature then so poor that forsooth only two lines of differentiation were at the beginning open for her effort? May we not rather believe that Life's tree may have risen at first in hundreds of tentative trunks, of which two have become in the progress of the ages so far dominant as to entirely obscure less progressive types?" Dealing with the same problem in KNOWLEDGE of January, 1899, Sir Edward Fry remarked of the myxies, "their locomotion and rapacious youth seem to shut them out from the plants; their stationary condition and their production of sporangia from the animal world." But these fascinating subjects form only the introductory part of the book before us, the function of which is to provide a list of all species of the myxomycetes hitherto described from North and Central America. The volume is essentially one for the serious student, who will find in it an authoritative account of the present state of knowledge in this department of biological science.

The Letters of Faraday and Schönbein (1836 to 1862). With Notes, Comments, and References to Contemporary Letters." Edited by Georg W. A. Kahlbaum and Francis V. Darbishire. (Williams and Norgate.) 13s. net. It is a little difficult for the ordinary student of chemistry who is in the habit of finding, by merely referring to some text-book or dictionary of his subject, the answer to each difficulty which presents itself in the course of his work, to change places in imagination with pioneers like Faraday and Schönbein, who, though studying subjects familiar to many schoolboys to-day, were able to discover no ready-made answers, but were entirely dependent upon what they could find out by their own experiments. Nevertheless, the excitement of discovering things for themselves they certainly had, and there is evidence in abundance, in their letters, that they thoroughly enjoyed it. The reader catches some of their enthusiasm in following the rather frequent letters which passed between the philosopher at the Royal Institution and his Swabian contemporary at Bâle. As the separate steps in Schönbein's researches on passive iron and ozone—to take only two of many examples—are duly explained in letters to Faraday, the reader, in spite of himself, begins to wonder what direction the researches will take in the next communication. Faraday was already lecturing at the Royal Institution when Schönbein was a young student, and though the latter was once, when visiting England, actually present at a Friday evening lecture, he was too shy to speak to Faraday after the lecture. It was not until some years later, when Schönbein was actually engaged at Bâle on his investigations respecting the action of nitric acid on iron, that he wrote to inform Faraday of some of the phenomena he had observed. Later they became personally acquainted. These letters are not only valuable, however, as a history of certain parts of nineteenth century chemistry, they will, it is to be hoped, be read also for the delightful picture they reveal of the almost brotherly fondness for one another which can exist between two actively engaged men of science. The intimate acquaintance one seems to acquire with Faraday's personality by reading these letters will well repay the student who takes up the volume. It is a sad story which Faraday has to unfold about himself in many of his letters. Frequent ill-health and constant loss of memory had to be reckoned with, and when we remember the amount of work Faraday accomplished, we can form a rough estimate of his steadfastness of purpose and devotion to science. The editors have done their work well—their notes supply just those links which are necessary to enable the reader to properly appreciate the letters.

"The Mind of the Nation: a study of political thought in the Nineteenth Century. By Marcus R. P. Dorman. (Kegan Paul & Co., Limited.) 12s. This is a substantial essay of some 500 pages on the constitution and government of the United Kingdom, written from the standpoint of the superior person who knows all about it. It follows as a matter of course that the writer's opinion of his fellow countrymen, whose political genius has always excited the admiration of the world, is of the poorest. "No one could maintain," he says, "that more than five per cent. of the voters have any real knowledge of politics at the present time." We are not, of course, concerned to canvass this proposition, but if it is true we fear that the proportion is not likely to be increased by a study of Mr. Dorman's book, which is marred both by loose statement and obvious bias. What are we to make, for instance, of

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his criticism of the practice of questioning ministers in Parliament, a practice which has been found of the very greatest utility by ministers themselves, and which the writer thinks should be stopped. Wherever this practice is abused the remedy is clearly in the minister's own hands, and, further, is frequently applied. But what is to be said for a teacher in parliamentary practice who appears to be labouring under the de'usion that ministers are in the habit of putting down questions addressed to their own colleagues (page 288). Here he has been relying, as Sheridan said, on his imagination for his facts. Then, again, the statement that Peel was enabled to carry his measure for the repeal of the Corn Laws because he was supported by a sufficient number of his own followers is quite at variance with the fact that some 250 of them voted against him. And the compiler of the Peel papers is surely Mr. C. S. Parker, sometime and a long time member for Perth, and not Mr. J. S. Parker. The book may be commended to those who are able to apply the necessary corrective, but it will not further the knowledge of the student in history, or the understanding of the citizen in the form and practice of the Constitution.

"The Grammar of Science." By Karl Pearson, M.A., F.R.S. (A. & C. Black.) 7s. 6d. net. This is a second edition of a most important work which has been thoroughly revised and much enlarged. Two entirely new chapters on Natural Selection and Heredity, embracing a popular account of Prof. Pearson's own more recent work in this direction, have been added. There is a peculiar opportuneness about the appearance of a new edition of this clear exposition of the scientific method and the claims of science to be regarded as the educational instrument, par excellence, for a training in citizenship. The inauguration of the new Board of Education which is to be immediately effected will focus attention upon the claims of the different schools of thought to be regarded as the final courts of appeal in questions of pedagogic expediency. We can conceive of no more convincing advocacy of the peculiar fitness of a training in the methods of science as a preparation for active life than is accorded by this volume. The function of science is, to use Prof. Pearson's words, "the classification of facts, the recognition of their sequence and relative significance." And, again, "modern science, as training the mind to an exact and impartial analysis of facts, is an education specially fitted to promote sound citizenship." Other claims of science are set forth in the same luminous manner. The light science brings to bear on many important social problems, the increased comfort it adds to practical life, and the permanent gratification it yields to the æsthetic judgment, are all reviewed in an equally masterly fashion. The important part which science must take in human development makes it an imperative necessity to have the fundamental concepts of modern science enunciated with logical clearness, and Prof. Pearson's criticisms of eight years ago, with the additions of to-day, can have nothing but a salutary effect in making men of science themselves more rigidly scientific. We have been again and again impressed in examining "The Grammar" with the remarkable lucidity of Prof. Pearson's explanations. The educated person, whatever the particular branch of knowledge with which he is familiar may be, will have no great difficulty in following the arguments here set forth, provided only that he commences his study with an open mind and a teachable spirit. We sincerely hope that another eight years will not elapse before the third edition is called for.

"Experimental Physics." By Eugene Lommel. Translated from the German by G. W. Myers. (Kegan Paul.) 15s. net. The reader who is familiar with modern British books on experimental physics will be disappointed if he expects to find in Prof. Lommel's treatise what is now considered to be an experimental treatment of the subject. The book is descriptive rather than experimental, and it contains no specific instructions to the student for enabling him to perform the experiments on which our knowledge of physical forces depends. For other reasons, too, the translation of the German volume seems superfluous. The same subjects are explained, and, we are bound to confess, better explained, in several other books already familiar to teachers. Nor is the volume better illustrated and more up-to-date than those we have in mind. There is, moreover, a growing disposition to discourage the use of these general reviews of the whole domain of physics, and to substitute more specialised accounts of the main branches, so that we are compelled to say that the book is unnecessary, and cannot be recommended either to teachers or students.

"Journal of the Society of Comparative Legislation." Edited by John Macdonell and Edward Manson. New Series. No. 3. (John Murray.) 5s. The third volume of this invaluable work is distinguished by a full and detailed review of the legislation of the British Empire in 1898, to which Sir Courtenay Ilbert contributes an introduction. Among the subjects dealt with by experts on constitutional law and general legal topics will be found an article by Mr. A. Wood Renton on "Indian and Colonial Appeals to the Privy Council"; a paper on Suzerainty," by Mr. W. P. B. Shepheard; and an instructive comparison of Truck Legislation in England and on the Continent, by Miss A. M. Anderson, one of Her Majesty's Inspectors of Factories. The writer of the valuable notes at the end of this volume makes an interesting comparison of the legislative procedure in our House of Commons and in the French Chamber of Deputies, not always to the advantage of our method. In the French Chamber, however, it is undeniable that the House itself does not enjoy the same control of legislative projects that is possessed by the House of Commons.

For the accommodation of persons wishing to view the Eclipse of the Sun, which takes place on Monday, May 28th next, Messrs. Cook have arranged a conducted tour, leaving London May 21st, visiting Paris, Bordeaux, Biarritz, Madrid, and Talavera, where the total phase of the eclipse will be visible.

BOOKS RECEIVED.

Recent and Coming Eclipses. Second edition. By Sir Norman Lockyer. (Macmillan.) 6s.

Wireless Telegraphy. Fourth edition. By Richard Kerr. (Seeley.) 1s.

Horns of Honour. By Frederick Thomas Elworthy. (Murray.) Illustrated. 10s. 6d. net.

Object Lessons in Botany. By E. Snelgrove. (Jarrold.) 3s. 6d.

Practical Zoology. By T. J. Parker and W. N. Parker. (Macmillan.) Illustrated. 10s. 6d.

Remarkable Eclipses and Remarkable Comets. By W. T. Lynn. (Stanford.) 6d. each.

The Naturalist's Directory for 1900. (L. Upcott Gill.) 1s. 6d. net.

Life of Dr. Arnold. By Dean Stanley. (Ward, Lock.) 2s.

The Story of the Nations—Modern Italy. By Pietro Orsi. (Unwin.) 5s.

The Flowering Plant. By J. R. Ainsworth Davis. (Griffin.) Illustrated. 3s. 6d.

Ferric and Heliographic Processes. By George E. Brown. (Dawbarn and Ward.) 2s.

Flowers of the Field. By Rev. C. A. Johns. (S. P. C. K.) Illustrated. 7s. 6d.

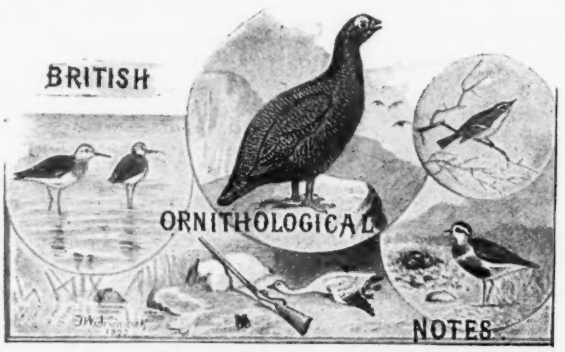
Chatty Object Lessons in Nature Knowledge. By F. W. Hackwood. (Longmans.) 3s. 6d.

Technical Education Returns in England, Wales, and Ireland. (Eyre & Spottiswoode.) 1s.

The Studio: an Illustrated Magazine of Fine and Applied Art, March, 1900. 1s.

Tools and their Uses, Repoussé and Metal-Chasing, Turning Lathes. "Useful Arts and Handicrafts Series." Dawbarn & Ward.) 6d. each.

The Norwegian North Polar Expedition, 1893—1896, Scientific Results. Edited by Fridtjof Nansen. Vol. I. (London: Longmans, Green & Co.) 40s.



Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

Bittern in Devonshire.—This neighbourhood participated in the flight of Bitterns which seems to have visited England this winter. On January 18th, when walking on our marsh bank, a Bittern rose within a few yards of me. It appeared in a very weak state, and after flying a short distance plumped into the tall reeds fringing the bank. I left him undisturbed, and as some days afterwards a Bittern was seen flying across the river here, I hope he has escaped destruction. I learn that one was killed in the marsh just outside Exmouth, on January 23rd. The last great

flight of Bitterns in Devonshire was in the winter of 1890-91.—W. S. M. D'Urban, Newport House, near Exeter.

Winter Visitors to Devonshire.—On the 11th December, 1899, a great movement of birds took place from the eastward, and there was a great influx of lapwings, golden plovers, ducks, coots, water rails, snipe, dunlins, mistle thrushes, chaffinches, starlings, larks, and ring doves, into South Devon. There was a severe frost on the 14th and 15th, followed by a south-westerly gale on the 16th. About this time there was a run on the holly-berries, and they were soon cleared off by the mistle thrushes and ring doves, which filled their crops almost to bursting with them. There was another influx of birds on 13th January, 1900, when vast flocks of lapwings again showed themselves, and ring doves, coots, and wild ducks again became numerous. On 26th January, song thrushes appeared in astonishing numbers on grass fields, and the bushes in the shrubbery after dark were alive with them. Blackbirds, mistle thrushes, and starlings also became very plentiful. When the frost set in on February 8th, redwings became extremely plentiful here, feeding amongst the undergrowth in the wood. Fieldfares were not numerous here, but Mr. E. A. S. Elliot informs me that after the heavy snow storm on the 13th, they appeared in extraordinary numbers at Kingsbridge. Lapwings and redwings became extremely weak here, and the latter fell an easy prey to cats and sparrow-hawks.—W. S. M. D'Urban.

Wild Robins as Pets.—Last summer we remarked some young Robins in our garden, which seemed inclined to become familiar, and sitting out daily in my Bath chair I amused myself feeding them, and very soon induced two or three of them to take crumbs from my hand. One in particular became so tame that my daughter suggested trying him with pieces of biscuit held between the lips, and after one or two trials he came quite freely, flying from greater distances each day, and poising like a hawk moth before snatching the morsel from our lips. This became a regular game with the bird, and two of his companions soon followed his example, and took biscuit from our lips, when they had quantities of other food dug up by the gardener. I am sorry to say our six pet Robins fight furiously, and a hen Blackbird often watches for, and secures the crumbs they let fall.—Frances T. Battersby, Cromlyn, Rathowen, W. Meath.

Egg Inclosed in another.—A friend has recently sent me two eggs laid by one of his pigeons. One of them is of unusual size ($2\frac{1}{4}$ inches in length), the other a little less than $1\frac{1}{2}$ inches in length, i.e., a little under the normal measurement. The small egg was found inside the big one. This is the only instance that has come to my notice of one egg being enclosed within another egg.—F. W. Headley, Haileybury.

[A similar occurrence in the case of a fowl's egg was reported in the "Field" for September 2nd, 1899, when the Editor made the following remarks:—"The occurrence is uncommon if considered in proportion to the number of eggs laid, probably one in many thousand; nevertheless, a year rarely passes that we do not receive a specimen. The explanation of the curiosity is as follows: Normally, the yolk, as it passes down the long oviduct, is enveloped in the concentric layers of the white, then the membrane, and finally the shell. If, in place of being extruded, an abnormal reversed action of the oviduct takes place, the egg is carried back, and meeting with a second descending yolk, both are included in the outer coverings, and one egg within another results."—H. F. W.]

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Obituary.

Astronomy—more particularly the domain of celestial chemistry—is the poorer by the loss of Charles Piazzi Smyth, formerly Astronomer-Royal for Scotland. The son of Admiral W. H. Smyth, he was born at Naples, 3rd January, 1819. Called "Piazzi" after the discoverer of Ceres, he early took to the science, and became assistant at the Cape Observatory at the age of sixteen. In 1845, at the age of 26, he became Astronomer-Royal for Scotland, beginning his work with great anticipations which, alas! were destined to be congealed in a frigid sea of officialdom. After more than forty years' service he retired to Clova, near Ripon, protesting against the degenerating influence of red-tape. In retirement the ex-Astronomer-Royal devoted himself to the photographic study of the solar spectrum and of cloud forms. He gave the first detailed descriptions of the telluric bands; introduced the "end-on" mode of viewing vacuum-tubes, and adverted to the significance of the "rainband" for weather prediction. While at Edinburgh he reduced and published his predecessor's (Henderson) observations; installed, in 1855, a time-ball on the Calton Hill, and compiled an extensive star-catalogue. At Teneriffe, in 1856, he studied the quality of astronomical "seeing" at high levels, notwithstanding the persistence of "dust-haze" to a height of 11,000 feet. In 1882, at Madeira, he investigated the solar radiations with a fine Rutherford "grating." "Life and Work at the Great Pyramid," published by Smyth in 1867, exhibits a phase of thought which provoked much controversy at the time and led to the author's resignation, in 1874, of the Fellowship of the Royal Society. The Great Pyramid was erected, in his view, under the eye of Melchisedech, and its interpretation heralded the beginning of the millennium in 1882.

ACROSS THE DOWNS.

By Grenville A. J. Cole, M.R.I.A., F.G.S., Professor of Geology in the Royal College of Science for Ireland.

From Dorchester to Norwich, from Flamborough Head to Beachy Head, we all know the broad chalk uplands, broken at one point by the composite valley of the Wash, at another by the clays and sands of London, and again by the wooded excavation of the Weald. There are no peaks, and few decided summits, on these plateaux; from the long back of the Cotteswolds, we see in the south-east the next great step of England facing us, its top almost level, and sending out spurs into the richer country at its feet. The scarp rises smoothly, covered with short grass; the cloud-shadows sweep across it, unbroken and well outlined, forming almost a picture of the sky; and here and there a clump of beech-trees, or a circular British camp, forms the only feature on the crest. At morning or evening, however, the level sunlight picks out the combes on the escarpment, great rounded hollows, in which trees may cluster along some ancient watercourse. Elsewhere, it is a dry country, and most of the streams that carved out the combes have long since vanished into the earth.

This typical scarp can be seen on the way from

Cirencester to Marlborough, or between Oxford and Henley, or, again, between Aylesbury and Amersham; it is formed by the upturned edge of the Upper Cretaceous series—a series which has been swept off from the surface of central England and which here finds its present boundary. The plateau, when we climb to it, falls gently towards London, and streams have cut valleys in it, running south or east to join the Thames. This drop in the country corresponds to the dipping surface of the strata, and the next scarp is produced by the Eocene edge above them.

On the Cretaceous escarpment, the white quarries in the Chalk are everywhere in evidence. Here and there, pagan tribes and Christian imitators have scraped out great white horses on the slopes, which are visible, as geological signals, fifteen or twenty miles away. Sheep are pastured on the plateau, which is set with the little huts of their guardians, quaint affairs on wheels, resembling bathing-machines escaped. At times, a wood of beech and ash has been spared, and the road goes straightway through it, much as it did in prehistoric times. In the barer landscapes, where the forests were devastated, in all probability, by Britons and Romans for their camp-fires, we may see the tumuli, the graves of ancient days, forming grass-covered hillocks, ten, twelve, or twenty of them at a time, set upon the wind-swept sky-line. Even where the plough has made a brown patch in this open country, a gentle swelling in the field, seen when the sun is low, often reveals one of these "barrows," which are doomed to disappear amid the farmland.

In this bleak country stands Stonehenge, the one superb landmark on the way from Andover to Wells; away in the north is Avebury, at the forking of the three Bath roads, its huge monoliths rising among the gardens of a little village. Both these monuments, mainly formed of sandstone blocks, bear witness to the Cainozoic strata that once covered all the English Downs. Close to Marlborough, such masses still lie tumbled in the hollows, like the talus of a mountain-side; but in most cases they have been broken up, during centuries, as the only stone for walls or buildings. Formerly, sands must have spread across the country, as they still do in the Bagshot area; and the residual blocks, known locally as "sarcens," represent those parts of the beds that became cemented together and escaped decay. The "sarcens" are thus as much geological outliers, cut off from the London basin, as are the cappings of clay and conglomerate that we find left stranded on the edges of the Surrey Downs.

When man took possession of this rolling plateau, which is typified in Salisbury Plain or Marlborough Down, every village required its defence, each cluster of huts became a fortified encampment. The finest enclosure of the kind is seen in Old Sarum, which remained the official centre of the district down to Norman days. Even as late as the thirteenth century, the cathedral stood here within ancient British walls. This spot becomes of special interest to us, when we compare it with the cities, ringed about to this day, that we shall see when we go eastward and invade the plains of Picardy. The Romans, the Saxons, and the Danes, have ranged over our plateau of the Chalk, just as the English, the Spaniards, and the Germans, have made their pastime in the unfenced fields of northern France.

The Chiltern Hills lie on the south-east side of a great Cretaceous arch, formed by the broad folding of the strata that went on through Cainozoic times. We are unaware how far the Chalk spread westward; the clear deep sea, unburdened by detritus, in which this white limestone was laid down, may have lapped round the island-mass of Wales, and crossed by way of Cheshire into Ireland. It is certain that it spread, across a pebbly shore, over all the east of Ulster, and found its north-western boundary in the stubborn hills of Donegal. The chalk cliffs of the county of Antrim, gleaming from beneath their protective covering of basalt, may form, perhaps, the far side of the Chiltern arch, the whole intervening mass having been swept away from the crown of an enormous anticlinal.

The same gentle type of folding brings the Chalk down under London, and up again to form the North Downs of Kent and Surrey. The arch which follows this downward curve has been breached by the rivers that flowed over it, some going northward to the London Basin, some southward to the English Channel; and the clays and sands exposed by its removal give us respectively the oak-woods and the fir-clad ridges of the Weald. The South Downs, formed by another typical Chalk scarp, thus face the North Downs across a gap of thirty miles; but the two ranges merge on the west side, and we find the arch unbroken when we trace it to the heights of Selborne. Thence its crown spreads westward, forming a plateau country, until it dies out in the bleak upland north of Salisbury.

The east and west trend of the Wealden arch is no doubt connected with the pre-existing buried ridge, which is known to us by borings, and which runs beneath the London Basin. The Cretaceous rocks were pressed against this obstacle when the broad Cainozoic folds were formed; and their general north-east and south-west trend became here locally disturbed. When we cross the Channel to the white Chalk cliffs of Normandy, we find our Downs again, this time sloping south-eastward towards the Paris Basin.

There is little wonder that the Norman adventurers, and successive English kings, felt themselves so much at home on either side of the Channel. The woods on the French side are, perhaps, a little more frequent along the hollows; but the crisp short grass upon the slopes above, the white quarries, and the crops that struggle with a stony soil, recall at every point the familiar Chalk of England. The rivers, as with us, have cut long valleys, out of which the roads climb steeply; and the heights along the Seine near Rouen may well remind us of the best part of the Thames at Henley. The open plateaux contain, as in our country, primitive little hamlets, often set back from the main routes, among their own trees, and clustered round a village green; the towns lie below, along the Somme, the Oise, the Aisne, and a hundred smaller streams. The forests have been more carefully preserved than in England, and cover large areas of the uplands. One may ride for miles along the straight level roads, through dark woods, in which the deer move softly; and here and there we emerge on some huge chateau, which, thanks to Viollet-le-Duc, takes our thoughts right back to Froissart, or the dim knight-errantry beyond.

On the north, the country is open to Flanders, and repeats all the features of the Netherlands. Windmills, canals, boats that appear to sail across the meadows, barns that assert themselves as the prominent features of the landscape, show how the Chalk has here dropped to the level of the sea. The old brick houses have a Flemish air, and the double names above the village-shops are certainly neither French nor Norman. The hamlets of Zutkerque and Volkerinckhove fail to conceal their origin; Moringhem, Ruminghem, and Salper-

wick, alike connect us with the north. As for the latter name, it carries us away to our own east-country fenland, where our Chalk also dips beneath the river-alluvium and the marshes, amid English windmills, wherries, and canals. In this open country, as we have hinted, each city is still a fortress; we enter by narrow and often winding roadways, between loopholes and the mouths of cannon; and the tall churches, crowning St. Omer, Laon, or St. Quentin, have looked down upon sieges, and have outfaced many a civil war. The Chalk has much to answer for, in favouring the spread of armies, and in raising no barriers to invasion. The fords in the deep valleys have proved difficult to strangers in the past; but Crecy-en-Ponthieu and Azincourt, to name no others, record the failure to dislodge an enemy from the plateaux.

The broad basin in which Paris lies was formed by folding, at about the same period as our smaller basin around London; its eastern rim, corresponding to our Chilterns, away beyond the vineyards of Champagne, similarly looks out on the back of the French Cotteswolds, that is, on the Jurassic range that runs from Dijon, by Langres and Nancy, into Luxemburg. Beyond this Jurassic scarp, the Moselle, running northward, plays the part of the English Severn. From Gloucester to Dijon, we may, then, broadly picture one great synclinal curve, formed of the beds of the Cotteswolds, which rise again and terminate as the bold Cote-d'Or in France; these bear on their backs the wide Chalk Downs, the Vespasian's Camp at Amesbury to Chalons-sur-Marne, the exercising fields of two lost empires; and these Downs wrap round and enclose in their turn the still later beds of London and of Paris. We have sought the Chalk again in Antrim on the north-west side of this enormous basin; where shall we recover it on the south-east, across the Moselle or the Rhone?

The folding that has had such mild effects in most of the Anglo-Norman area shows here and there far more serious results. West of Guildford, the Chalk dips at 35°; and in Dorsetshire and the Isle of Wight its beds are in places contorted or even vertical. Similar contortions are well known near Flamborough Head; but we now proceed to a district where earth-wrinkling has actually destroyed our Downs, and has left us only local Cretaceous strips, caught in the synclinal folds. The anticlinals, following closely on one another, consist of Jurassic rocks; the escarpments of the Cotteswolds and the Cote-d'Or are repeated again and again in the course of a few miles; and the dip-slopes are often as steep as the scarps, which are formed by the upturned limestone edges. This region of repeated folding gives us the beautiful parallel ranges of the Juras. Among the beds involved are some that correspond to our "Lower Greensand" strata, which come out around the English Weald; but in Upper Cretaceous times the Jura ridge had probably already risen, forming a chain of islands in the sea.

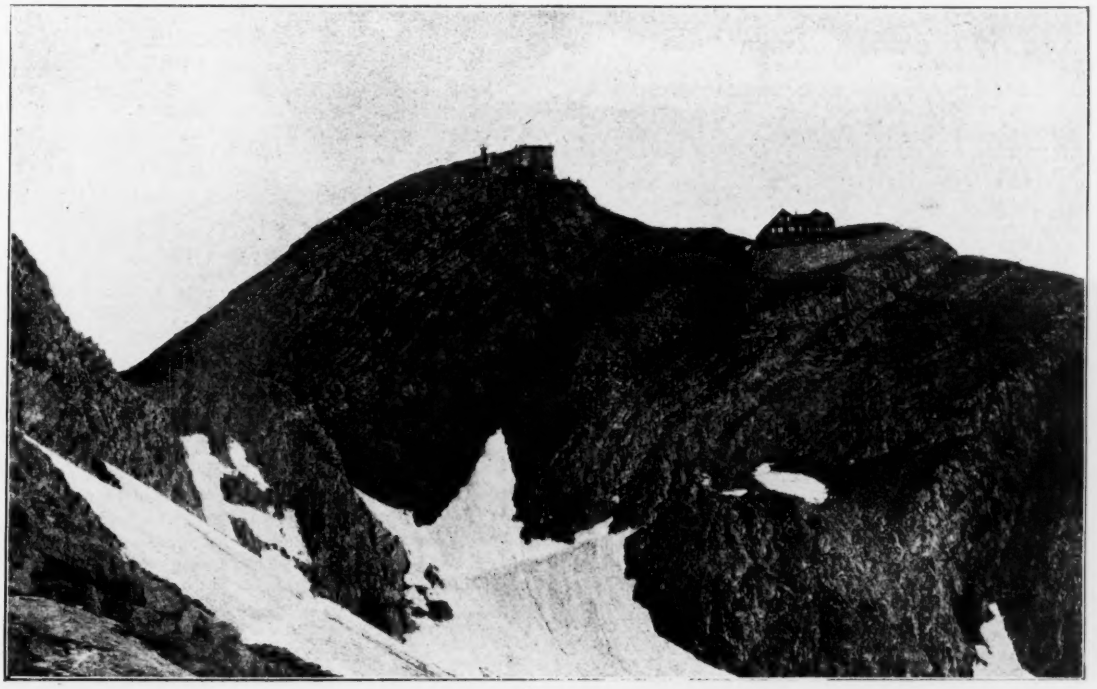


Fig. 1.—Summit of the Säntis, Switzerland, formed of Upper Cretaceous strata, with the dip-slope determining the mountain-side upon the left, and the escarpment forming the more craggy slope upon the right.

The Alps themselves, however, lay long beneath the ocean. The limestones that represent our Chalk were laid down in a clear sea that stretched unbroken into Syria; and on them the Eocene sea continued to deposit "nummulitic limestone," rich in foraminifera and other marine types of life. When the great Alpine movements came, which were already foreshadowed in the Juras, the whole Cretaceous series became crumpled together like a cloth. In successive periods, the central Alpine mass moved upwards, culminating at the close

of Miocene times; and denudation swept the Cretaceous and Jurassic limestones from it, leaving their contorted remnants in the foothills. Here they form superb scenery of slope and scarp, the higher strata, towering above the forests, being often ledged with snow. The Chalk, which is so soft and white in the English plateaux, is here represented by a compact and brittle rock, as grey and firm as our old Carboniferous Limestone. In fold on fold, it now comes out at the base of some inverted series, or now climbs five thousand feet, and caps a line of glorious crags. The capacity of these later geological deposits for forming mountains, when sufficiently hard pressed, is nowhere better seen than in the eastern Alps of Switzerland. The crest of the Santis, for example, in Appenzell, 2504 metres (8213 feet) above the sea, is formed by an overfolded mass of "Seewerkalk," Gault, and "Schrattenkalk." Half of the topmost anticlinal is seen in our picture (Fig. 1), with the observatory and hotel upon it. Translated into our English equivalents, the highest crag represents the escarpment of the Surrey Downs; the dark and narrow band, starting from the left of the hotel, is the Gault sand and clay, known to us in the level land, set with brickyards, at the foot of our soft green hills; and the mass below represents our "Lower Greensand," which is familiar in the Leith Hill range. The Eocene beds, corresponding to those of the London Basin, are squeezed in and folded under the Cretaceous masses on the north, far away below the crags of the Ebenalp and Oehrli; while we may see a representative of the Paris Basin in the synclinal on the south at Wildhaus.

The Eocene masses form hummocky knolls, as large as British mountains; the Greensand and Chalk are uplifted and glorified as veritable mountain-peaks. On the Titlis, nearer to the St. Gotthard, the Eocene itself can be seen infolded, at about 10,000 feet above the sea.

South of the Eocene basin of Wildhaus, the Cretaceous beds again arise, in the superb line of crags that look down into the Lake of Wallen. The crests of the Churfirsten are often capped by "Seewerkalk," and the whole Cretaceous and half the Jurassic systems appear here on one huge rock-wall.

The bold Alpine movements have, however, raised these strata to a dangerous eminence. Contorted as they are, the materials of the foothills are always in a state of strain. The beds are ready to snap asunder at the shock of earthquakes, or to slide on one another at any disturbance of equilibrium, such as may be caused by ordinary denudation. The disastrous landslip of Elm, in 1881, occurred among Eocene strata; that of the Rossberg, above Goldau, in beds comparable to those of Totlands Bay in the Isle of Wight; while the Diablerets, above the Rhone valley, form a noted spot for rock-falls, which come down from an upper Cretaceous scarp 10,000 feet above the sea.*

It is interesting to compare these destructive episodes with the slides of Chalk that occur from time to time at Dover, or along the Dorset coast. The earth-movements that raised the Alps folded and fractured England.† Lower Pliocene strata, with marine fossils, are known on the edge of the escarpment of the Kentish Chalk, and assign a modern date to the anticlinal and also to the excavation of the Weald. As we look across France to the notched anticlinals of the Alpine foothills, and to the marine Pliocene beds uplifted on their backs in Italy, the analogy of structure in the two areas becomes close indeed. The movements date in both cases from the same period of unrest; but their ultimate intensity has been vastly different. The broad curves of the French and English Chalk represent the far-reaching waves of an earth-storm that was gathering and breaking in the south. That storm spent its force in the great lines of elevation from the Pyrenees to the frontier of Tibet; but its after-tremors may occasionally reach us, and subsidiary folds may be still forming beneath our placid English Downs.

* Compare G. Cole, "Open-Air Studies" (1895), p. 72.

† *See* particularly A. Strahan, "On Overthrusts of Tertiary Date in Dorset," *Quart. Journ. Geol. Soc.*, Vol. LI. (1895), p. 549.

THE MUD-NEST BUILDING BIRDS OF AUSTRALIA.

By D. Le Souëf, c.m.z.s.

In Australia there are three genera of birds, not including swallows, which build mud nests, and strange to say these three genera contain but a single species each, and it is difficult to know in what group to place them. They are Corcorax melanorhamphus, Struthidea cinerea, and Grallina picata. All these, and especially the two first named, as will be explained below, are very sociable birds.

Corcorax melanorhamphus: "White-winged Chough."

This bird has been given the vernacular name of "Chough," because, although not strictly a Chough, it is most nearly allied to that species. It is popularly called the Black Magpie, but popular names, as is well known, are often far from correct. The bird inhabits open forest country, and, except in the extreme north and north-west, is found all over Australia, being in many localities plentiful.

The general colour of the bird is black, but the inner web of each primary is white for a short distance from its base; this white marking is only seen when the bird is flying, but it is then very conspicuous. Curiously enough there frequently seems to be a festering sore place on the skin at the base of the bill, and the birds themselves often have an unpleasant odour. Their food consists of insects, and the birds generally feed on the ground. When disturbed they

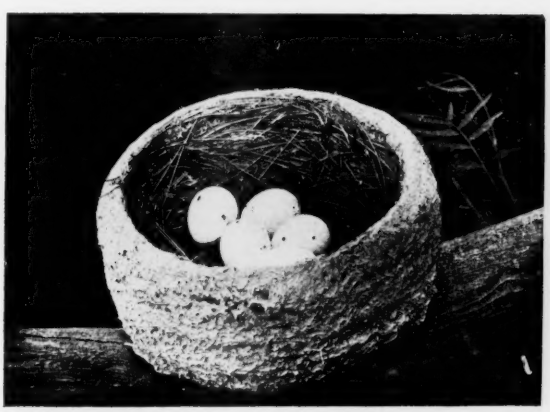
Nest of *Corcorax melanorhamphus.*

fly into the lower branches of a tree, and, hopping and flitting from one branch to another, soon reach the

top, and fly away. When one bird is shot at, and wounded so that it is prevented from escaping, its cries attract the rest of the flock to it, and, coming within gun shot, are easy victims to the sportsman. They always go in companies or flocks, which, during the nesting season, consist of from six to fifteen birds, but later on, when the young birds have left their nests, the flocks often aggregate up to thirty or more. These birds are heavy flyers, but otherwise very active. During the nesting season, the male bird, when in the presence of the female, often goes through various antics, such as spreading out his wings and tail, in order to attract her attention. In the latter end of August or early in September they commence building, several of the birds helping to construct the same nest. Three are generally built by one company during the season, a new one being started as soon as the eggs in the previously made nest are hatched out. From what I have observed, I consider that several hen birds lay in the same nest, the number of eggs varying from four to eight. Should one sitting bird be shot, another will take her place, and I have known three birds to have been shot from one nest, after which they were left in peace to their family cares. When the young are hatched, several birds feed them, and consequently they grow fast. The nest, which is the common property of the flock, is a bulky, open structure made of mud and weighing sometimes as much as nine pounds. It is lined with either dry grass, fur, or shreds of bark from the Eucalyptus trees, and is generally placed on a dry horizontal branch at a considerable distance from the ground. As the branch chosen is often small compared with the nest itself, the birds build the sides of the nest down below the branch, and thus their home is balanced and held on more securely. The diameter of the interior of the structure is six inches and the depth three inches. The eggs are white, with bold irregular dark brown markings, and average dimensions of 1.52 by 1.12 inches.

Struthidea cinerea: "Grey Jumper."

These interesting birds are very similar in their habits to the Corcorax, and are often found in their company. They also live in flocks of from five to fifteen birds, and in consequence are called in some



Nest of *Struthidea cinerea.*

districts the "Twelve Apostles." They are not found in the extreme north of Australia, nor yet on the north-west side, but are everywhere else. Active birds, of prevailing grey colour, they have a harsh note, and are noisy. They generally secure their insect prey on trees and are only occasionally seen on the ground. Like the Corcorax, their nest is common, and several birds help in building it. Three nests are usually built during the season, and a fresh one is commenced when the young birds in the first are about a week old. From four to eight eggs are laid, evidently by several hen birds, as in a nest. Mr. H. Lau found, belonging to a flock of twelve birds, eight eggs were laid in six days. The mud nest, shaped like a basin, is neatly built and generally perfectly spherical. It is well lined with long pieces of dry grass, the interior diameter measuring four inches and the depth two inches, and is supported on a horizontal bough, occasionally low down, but generally from nine to fifteen feet from the ground. The eggs are white with a few blackish streaks, generally on the larger end. On some eggs the markings are altogether absent.

Grallina picata: "Magpie Lark."

This beautiful and graceful bird is found in every part of Australia where there is water. Often to be seen about country homesteads, it is a great favourite, strictly insectivorous, and very tame.

It has various local names—Peewit, from the double note the bird utters, being the most common. During the nesting season the birds are generally seen in pairs, but in the winter months they often congregate together in considerable flocks, which are composed chiefly, I think, of young birds, as the old pairs seldom seem to stray far from their favourite locality, and generally nest year after year either in the same tree or not far from it. Their old nests are frequently used by other birds, such as the Wood Swallows (Artamus), and Frogmouths (Podargus), which build their own homes in them. Many birds, especially hawks, prefer using old nests of other birds, which they trim up to suit their own requirements, instead of building fresh ones for themselves. The Grallina invariably feed on the ground and generally in moist situations. The inside of their open mud nest measures four and a half inches in diameter by three and a half inches in depth. It is

Nest of *Grallina picata.*

lined with dry grass, although occasionally bark or feathers are used. Both birds help in its building, and, after finishing, they leave it for about a fortnight to dry before occupation. Some tree in the vicinity of

XUM

water is always chosen as a site for the nest, and often the Black and White Fantail (Rhipidura tricolor) builds its cobweb-covered nest close to that of the larger bird, and joins with its neighbour in driving away hawks and other common enemies. Many birds like to build in company, as I have frequently noticed when travelling in the country. Even the little Acanthiza chrysorrhoa makes its nest among the sticks which form the foundation of the Eagle's home (Aquila audax). Five eggs form a full clutch, and they vary much in colour and disposition of markings, some having a white ground and others a reddish pink. Again, in some eggs the reddish-brown markings form an irregular zone round the larger end, while in others they are scattered all over the egg. Some eggs are elongated in shape, others much more rounded, and their average measurements are 1.18 by .82 inch.

Microscopy.

By John H. Cooke, F.L.S., F.G.S.

"Microscopy and Micro-technique," by Dr. Albert Schneider, of the North-western University, is another work which we can confidently recommend to our readers. The self-explanatory title enables us to dispense with a description of its aims. It embodies many facts and suggestions resulting from long observation and a very varied practical experience; and it is specially suitable as a work of reference for all who are interested in biological research.

Mr. C. A. Kofaid, of the Illinois Biological Station, has devoted, during recent years, considerable attention to the biology of the plankton; and his investigations have shown that the Henson method of collecting with a silk net, as usually practised, is very faulty and likely to lead to erroneous conclusions. The leakage of the planktonts through the yielding meshes of the silk, caused by their struggles and the pressure of the filtering water, is so considerable as to give rise to grave errors in the final computations. A considerable volume of the plankton is lost at all seasons of the year, and in some instances the actual catch of the silk net is but a small fraction of the total present. The plankton thus lost is composed very largely of minute algæ, which constitute a fundamental link in the cycle of aquatic life. To prevent these losses he now employs a filter made of filter paper No. 575, Schleicher and Schüll. It is very free from lint, and does not easily tear when wet. As the filtering proceeds, the plankton is condensed in the bottom of the funnel by means of a fine spray from a hand bulb. The method is very simple and rapid, and it yields from 75 per cent. to 80 per cent. of the planktonts, as compared with 45 per cent. to 50 per cent. with the silk net. The Henson method answers well enough for the larger forms, such as the *Entomostraca* and the larger *Rotifera* and *Protozoa*, but it is quite inadequate for the retention of *Melosira*, *Peridinium*, *Dinobryum*, *Raphidium*, *Euglena*, and other of the smaller and frequently very abundant planktonts.

At a recent meeting of the Royal Microscopical Society, Dr. Measures exhibited an instrument for micrography made by Zeiss, having a new form of fine adjustment, which admitted of the arm being made of any length without throwing any weight upon the fine adjustment screw. The manner in which the speed of the fine adjustment is reduced is most ingenious. The motion was extremely slow, being only 1·625 in. for every revolution of the screw. The application of the principle of the endless screw is a novel way of slowing down the fine adjustment. Among other advantages claimed for the apparatus are the increased length of arm and the reduction of weight on the fine adjustment to one-fifth of that which is usually put upon it.

For histological and biological work, an Abbè sub-stage condenser is indispensable. With the condenser open a cone of light, having an angle of divergence of 120°, is brought to a focus upon the object. Viewed with this intense light, the delicate contours of transparent objects, which are made visible by differences of refraction, are almost entirely lost, and the stained portions of the specimens which would be, without the condenser, more or less concealed by the outlines of the unstained portions, stand out in bold relief. This "isolation of the stained image," as Koch terms it, is of great value in histological study. An Abbè condenser should be found in every histologist's laboratory.

Ground glass is a useful adjunct to the laboratory appliances of microscopist and microphotographer; but it is not always possible to obtain glass having a grain of sufficient fineness to be of much use. Ground glass may be easily prepared by placing some fine emery powder between two pieces of glass, and then rubbing the glasses together for a few minutes. If the glass becomes too opaque it may be rendered more translucent by rubbing some oil upon it.

One of the principal reasons for using lacquer on microscopes is to protect the metal from oxidation. Lacquer is readily soluble in alcohol, and great care should therefore be taken when using this reagent. The practice of cleaning the brass work of the instrument with alcohol is, therefore, to be deprecated.

NOTES ON COMETS AND METEORS.

By W. F. Denning, F.R.A.S.

Giacobini's Comet (1900 a).—The discoverer gives parabolic elements in Ast. Nach. 3624, from observations on January 31st, February 3rd and 6th. The comet is now practically invisible, being extremely faint and situated too near to the sun for satisfactory observation. Its perihelion passage will take place on April 28th, but there is scarcely a possibility that the object will be observable at this period even in very powerful telescopes. On February 21st the comet was observed by Kobold at Strassburg, and he describes it as 1 minute of arc in diameter, round, and between the 12th and 13th mag.

In April the relative motions of the comet and earth will cause the two bodies to begin to approach each other, and in May and June this approach will be very rapid, so that in July and August the comet will be much nearer the earth, and considerably brighter than it was at the time of its discovery. It will also be very favourably visible as regards its position in the sky. The following condensed ephemeris by A. Berberich (Ast. Nach. 3627) will exhibit the varying position and distance of the comet during the ensuing six months:—

Date 1900.	R.A. H. M.	Dec. ° ′	Distance from Earth in Millions of Miles.
April 3 ...	1 44·4	+ 11 27 ...	217
,, 27 ...	1 33·2	+ 17 28 ...	214
May 29 ...	1 9·0	+ 27 7 ...	180
June 30 ...	23 46·9	+ 41 31 ...	128
Aug. 1 ...	19 36·3	+ 41 20 ...	111
Sept. 2 ...	17 39·2	+ 17 50 ...	170
Oct. 4 ...	17 23·2	+ 5 55 ...	251

Large Comets.—It is now many years since we were visited by a really large comet favourably visible in the evening sky. In June and July, 1881, a fine comet presented itself in the northern heavens, and in August of the same year Schaeberle's comet became fairly conspicuous as it passed under the well-known stars of Ursa Major. A brilliant comet with a tail 22 degrees long was perceptible in the autumn mornings of 1882. Since that year we have had several fairly conspicuous comets, but not one with a position and brightness which enabled it to arrest much public attention. It is a curious fact, to which the writer drew notice in the "Astronomical Register" for April, 1883, that the majority of the large comets of the present century have appeared at intervals of about 19½ years. There were several large comets observed in or near the years 1823, 1843, 1862, and 1881. If this cycle indicates something more than fortuitous agreements then we may expect to see several fine naked eye comets during the ensuing few years. This should be an encouragement to comet-seekers to redouble their efforts. But though the cycle referred to appears to be tolerably well marked it is difficult to understand how it could exist in relation to bodies having exceedingly long periods, and, moreover, it apparently fails in its application to the large comets of the 18th century.

Doubly Observed Meteors.—On January 25th, 11h. 10m., a meteor of about 2nd mag. was recorded by Prof. A. S. Herschel at Slough, and Mr. J. H. Bridger at Farnborough. The radiant was at 45 degrees plus 62 degrees, and the meteor descended from 65 to 44 miles over Warwickshire. On January 27th, 11h. 10m., a very slow-moving meteor of 1st mag. was registered by Prof. Herschel

at Slough and Mr. A. King at Leicester. Its radiant was at 98 degrees minus 10 degrees, and it fell from 57 to 45 miles, ending almost vertically over Leicester. These doubly observed meteors are valuable as affording distinct evidence of feeble radiant points which have not been previously observed at the same period of the year. Hence there is great utility in maintaining simultaneous watches, for a pair of accurate observations of a meteor will enable the radiant point of a scanty shower to be exactly determined, though such a shower may be too feeble to be ever recognised by isolated observation.

Large Meteors.—On November 27th, 9h. 20m., a remarkable bolide was seen by Mr. C. N. Neuoff at Sofia. It travelled from the square of Pegasus towards Capella, and broke into two parts. On February 11th, 8h. 19m., Mr. A. C. Panfield, of Tenbury, observed a meteor brighter than Sirius. It passed from Eridanus to 20 degrees S.E. from Sirius, and was visible for about 13 seconds

Stationary Radiants.—In Ast. Nach. 3623, M. Bredikhine gives the orbits of a number of showers composing the long enduring radiants near Beta Persei and Zeta Draconis. The differences in the elements induces him to believe that stationary radiation is brought about by a series of distinct streams supplementing each other from the same apparent directions. This explanation has been previously offered but it is quite inadequate to satisfy the observations. The accidental grouping of radiants would not enable them to cluster at certain centres to the exclusion of surrounding spaces. A number of different showers succeeding each other from the vicinity of a fixed star would give radiants round about the star, being sometimes E., W., N. and S. of it, but a stationary radiant retains a constant position relatively to that of the star near which it may be placed. This fact is of great significance, and negatives the idea that mere chance grouping is responsible for the production of stationary radiants.

April Lyrids.—The moon will be full on April 15th this year, so that the shower can be best observed in its later stages. As 1900 is not a leap year the maximum will probably occur on April 21st, when the moon rises at 13h. 23m. But in 1884 the writer observed a very active return of the shower on April 19th, 11h. to 12h. It seems necessary therefore to maintain a watch both on the nights of April 20th and 21st before moonrise. The shower is visible for about a week (April 17-24), and its radiant is a moving one like that of the August Perseids, but the Lyrids are usually so rare that this feature in regard to them has never been sufficiently investigated. Observers should carefully ascertain the position of the radiant on successive nights, and in this connection the meteors moving in declination will be very valuable as serving to indicate the R.A. accurately.

THE FACE OF THE SKY FOR APRIL.

By A. Fowler, F.R.A.S.

The Sun.—On the 1st the sun rises at 5.37 and sets at 6.31; on the 30th he rises at 4.36 and sets at 7.18. Occasional small spots may occur, but large outbursts are not to be expected. The sun is at its mean distance from the earth on the 1st.

The Moon.—The moon will enter first quarter on the 6th at 8.55 P.M.; will be full on the 15th at 1.2 A.M.; will enter last quarter on the 22nd at 2.33 P.M.; and will be new on the 29th at 5.23 A.M.

The following are the most notable occultations visible at Greenwich:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Apr. 3	B.A.C. 1373	5·7	8.47 P.M.	88	47	9.44 P.M.	275	235	4 0
,, 4	o Tauri	4·8	9.30 P.M.	71	29	10.22 P.M.	304	263	5 1
,, 8	a Cancri	4·3	11.46 P.M.	91	53	12.45	317	277	9 3
,, 21	ξ^2 Sagittarii	3·5	2.27 A.M.	87	110	3.42 A.M.	255	267	21 6
,, 24	c^1 Capricorni	5·2	3.23 A.M.	11	45	3.57 A.M.	306	337	24 7
,, 24	c^2 ,,	6·2	3.34 A.M.	83	116	4.37 A.M.	233	260	24 7

The Planets.—Mercury is the morning star throughout the month, but though he reaches an elongation of over 27° on the 24th, he is badly placed for observation in our latitude. Only in the tropics and in the southern hemisphere do western elongations in our Spring provide favourable opportunities for the observation of this planet.

Venus will be a very brilliant object throughout the month. On the 28th, at midnight, she will be at greatest eastern elongation, 45° 30'. During the month she travels from near the western boundary of Taurus to near the eastern limit of that constellation; on the 8th and 9th the planet will be nearly midway between the Pleiades and Aldebaran, and on the 28th between Zeta Tauri and Beta Tauri. The apparent diameter increases from 18" on the 1st to 24" on the 30th. At the middle of the month a little less than six-tenths of the disc will be illuminated.

Mars is a morning star, rising about 4.45 A.M. at the middle of the month, but with his apparent diameter of 4".2 is of little interest to observers. During the month he describes a long direct path through the lower part of Pisces.

Jupiter rises just before midnight at the beginning of the month, and a little before 10 P.M. at the end. During the month the apparent diameter increases from 38".0 to 41".0. The planet has a slow westerly motion in the south-western part of Ophiuchus, about 5° north-east of Antares.

Saturn rises about 1.45 A.M. at the beginning of the month, and about 11.45 P.M. towards the end. His path is very short, but 2 degrees north of Lambda Sagittarii. The planet is stationary on the 14th.

Uranus traverses a short retrograde path in the south-western part of Ophiuchus. At the middle of the month the planet will be nearly 2 degrees east and 1 degree south of Jupiter, lying nearly midway between Antares and Eta Ophiuchi throughout the month.

Neptune sets about 1 A.M. at the beginning and about 11 P.M. at the end of the month. His path is a short easterly one to the north-east of Zeta Tauri; the planet is 1 degree north of that star, 4m. 11s. following on the 1st, and 6m. 55s. following on the 30th.

The Stars.—About 9 P.M. at the middle of the month, Leo will be on the meridian, Gemini in the south-west, Orion in the west, Virgo in the south-east, Hercules in the north-east, and Ursa Major almost overhead.

Algol may be conveniently observed at minimum on the 20th at 9.45 P.M.

Chess Column.

By C. D. Locock, B.A.

Communications for this column should be addressed to C. D. Locock, Netherfield, Camberley, and be posted by the 10th of each month.

Solution of March Problem.

(J. K. Macmeikan.)

Key-move—1. B to R5.

If 1 . . . K to K4, 2. R to B8, etc.
1 . . . K to Kt6, 2. Q to KRsq.

Correct Solution received from J. Baddeley, Capt. Forde, H. S. Brandreth, W. Nash, J. W. Meyjes, Alpha, W. de P. Crousaz, K. W.

K. W.—The majority of the Knowledge corps of solvers will not try sui-mates. One or two short ones will be inserted from time to time, in notation, as you suggest.

J. W. Meyjes.—Your solutions to last month's problems did not arrive till after this page had gone to press; otherwise you would have been credited with No. 1, in spite of the clerical error.

G. B. Gooding.—P to Q4 is a near try, but Black can reply 1. . . . P × P en passant. Moreover after 1 . . K to Kt6, 2. Q to Q2, K to R6; 3. Kt to B5 is not mate, as the Black Pawn can cover the check.

W. Parkinson.—See reply to G. B. Gooding above.

J. T. Blakemore.—Correct solutions to J. G. Campbell's problems just too late to acknowledge last month.

Problems received with thanks from W. H. Gundry, N. M. Gibbins, W. Clugston. They will appear shortly if found to be correct.

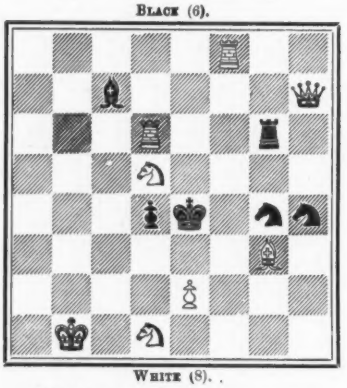
It is interesting to learn that the four-move problem which appeared in the October Number obtained first prize, out of 52 entries, in the problem tourney of the "British Chess Magazine." The composer was Karel Traxler, of Bohemia. Below are two of the prize-winners in the recent problem tourney of the "Birmingham Daily Post." Some judges might consider them superior to the first and third prize winners.

No. 1.

Second Prize.

By W. Gleave (London).

Black (6).



White (8).

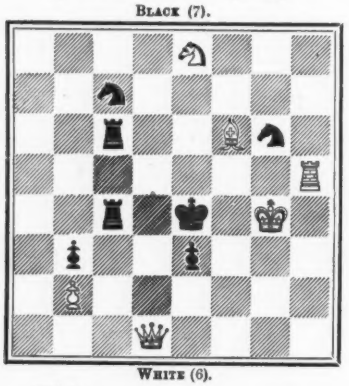
White mates in two moves.

No. 2.

Fourth Prize.

By Henry A. Wood (Shaw).

Black (7).



White (6).

White mates in two moves.

CHESS INTELLIGENCE.

The English side for the forthcoming cable match with America will consist of Messrs. H. E. Atkins, G. E. Bellingham, J. H. Blackburne, E. M. Jackson, Herbert Jacobs, T. F. Lawrence, F. J. Lee, D. J. Mills, H. W. Trenchard, and W. Ward. The reserves will be Mr. E. O. Jones, Mr. Physick, and Mr. Passmore. The match takes place on March 23rd and 24th at the Monaco Restaurant.

The annual Hastings and St. Leonards Chess Festival is fixed for March 30th to April 3rd inclusive. Messrs. Blackburne, Mason and Teichmann are the masters engaged. There will be the usual consultation games, and blindfold and simultaneous exhibitions, as well as some local events, including a match between teams of 100 players representing Kent and Sussex.

The City of London Chess Club has organised an Invitation Tournament, in which seven professionals and seven amateurs are to compete. The seven prizes to be given amount to £64. Play begins at 7, Grocers' Hall Court, Poultry, on April 5th, with an adjournment between April 12th and April 18th. The tournament will be an interesting test of the relative strengths of British amateurs and professionals, and will give the latter an excellent opportunity of getting into practice for the Paris International Tourney.

Mr. Bellingham is playing a match with Mr. Burn; the present score is 4½ to 1½ in favour of the former and as the match is limited to nine games Mr. Burn cannot now win it. At Chicago Mr. Marshall, the winner of the minor tournament in London, has defeated Mr. S. P. Johnstone by the narrow majority of 7 games to 6. Both players took part in the cable match last year, and will probably play again. Mr. Delmar has won two short matches with Mr. Halpern and Major Hanham.

In the South-Eastern section of the S.C.Ch.U. tourney, Hampshire succeeded in defeating Sussex by 9 games to 7, the latter team being two men short. Hampshire accordingly tied with Surrey for the leadership of the section, but were defeated rather easily in playing off the tie. The final will lie between Surrey and either Somerset or Gloucestershire.

The "Richardson" cup competition for Scottish clubs, limited to teams of five, has at length been decided. In the final tie the Glasgow Club defeated Edinburgh by 3 games to 2.

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